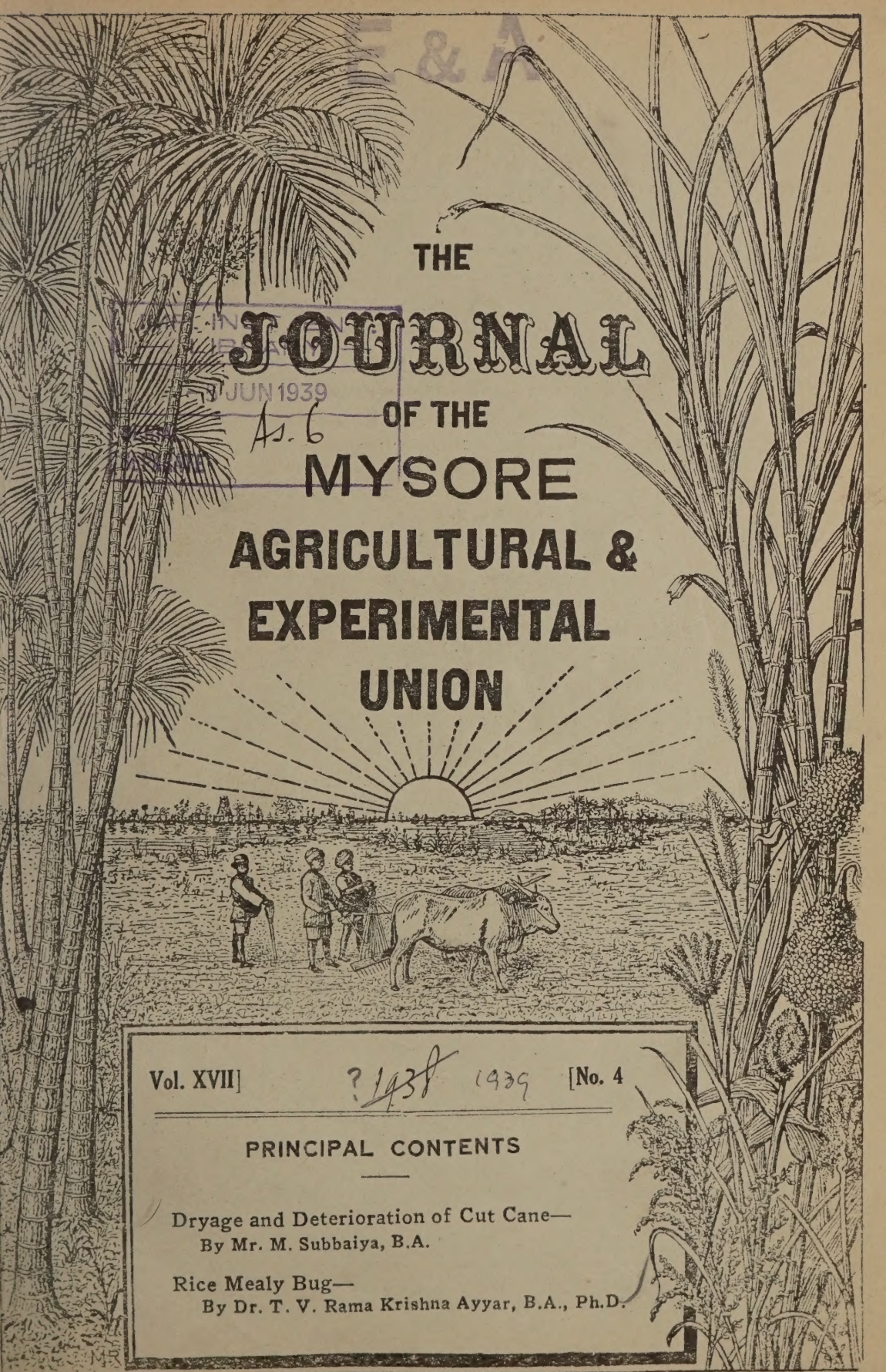

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THE JOURNAL OF THE MYSORE AGRICULTURAL AND EXPERIMENTAL UNION

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Dryage and Deterioration of Cut Cane on the Irwin Canal Farm, Mandya, Mysore

By

M. Subbaiya, B.A.
Assistant Chemist, Department of Agriculture, Mysore

Introduction

The Mysore Sugar Factory operating at Mandya depends almost entirely for its daily supply of 1,400 tons of sugarcane upon the ryots cultivating their lands within a radius of ten miles from the Factory. Some of the ryots deliver their cane at the weigh-bridges put up by the Sugar Company in several places wherefrom the cane is sent to the Factory by motor lorries. A portion of the daily supply of cane is received directly at the Factory yards from the ryots bringing their harvest on bullock carts. A certain amount of time is thus bound to elapse between harvesting, weighing and milling. As the ryot is paid on the basis of weight recorded at the weigh-bridges, it becomes important to know the amount of loss in weight of harvested cane exposed to weather for varying periods. As the harvested cane is

known to deteriorate rapidly it is equally important to know the rate of deterioration under the climatic conditions prevailing at Mandya and thus deduce the time that can safely be allowed to elapse between harvesting and milling so as to result in as little loss of sugar as possible to the sugar manufacturer. To obtain exact information about the above-mentioned points, systematic tests were carried out on the Irwin Canal Farm, Mandya, over a period of five months. The procedure adopted in these tests is as follows:—

Method of Sampling

One-hundred-and-fifty average stalks of the variety H.M. 320 which is the one exclusively grown in the area and supplied to the Sugar Factory were harvested from the same field and topped. The canes were then spread over the ground, each cane lying parallel to the other. Beginning from one end, six canes were counted and a mark was placed at the end of the sixth cane. In this way counting and marking were continued to the end thus dividing all the canes into 25 lots, each lot consisting of six canes. Then the first cane of each lot was picked up and all the canes were gathered together and bundled up. Out of the five canes left in each lot, the first cane of each lot was picked up as before and tied into a second bundle. In this way six bundles, each bundle consisting of 25 canes were formed, labelled and weighed. The first bundle which can be taken to represent a fresh sample, was then milled in a bullock-driven iron mill and the juice weighed. After thoroughly mixing the juice, a small quantity of juice was taken to the laboratory for chemical analysis. After a lapse of 24 hours, all the remaining five bundles were again weighed, but bundle No. 2 only was milled and the juice analysed. This procedure was continued at the end of every 24 hours until the last bundle was treated. The analytical data obtained are presented in Table I.

Discussion of Results

The first important thing to determine is the amount of loss in weight of cane due to dryage. As temperature and

TABLE I

Primary data

	0 hours	24 hours	48 hours	72 hours	96 hours	120 hours	Remarks
1. Weight of fresh canes in lbs.	77–8	94–8	100–0	83–8	80–8	95–8	Date of analysis :
Dryage per cent.	0	1·59	4·0	6·59	8·39	..	Last week of October 1937.
Brix (corrected)	20·32	20·25	21·38	21·98	22·24	21·71	Date of planting :
Glucose per cent. ..	0·222	0·511	0·979	2·307	2·926	3·157	5th July 1936.
Pol. sucrose per cent. ..	18·75	18·40	18·90	17·90	17·25	16·40	Number of canes in each
Purity	92·28	90·86	88·41	81·45	77·54	75·53	bundle = 25.
Reducing-sugar ratio ..	1·184	2·777	5·18	12·89	16·92	19·25	
Available sugar per cent. ..	12·89	12·34	12·20	10·11	9·0	8·17	
2. Weight of fresh canes in lbs.	100–0	94–4	101–0	104–0	104–0	94–0	Date of analysis :
Dryage per cent.	..	1·59	3·22	3·84	4·81	..	Last week of December 1937.
Brix (corrected)	21·31	21·84	21·84	22·81	23·33	23·33	Date of planting of cane :
Glucose per cent. ..	0·145	0·214	0·510	1·639	2·107	2·836	November 1936.
Pol. sucrose per cent. ..	20·05	20·50	20·0	19·10	19·0	18·45	Number of canes in each
Purity	94·08	93·87	91·56	83·73	81·43	79·70	bundle = 25.
Reducing-sugar ratio ..	0·723	1·044	2·55	8·581	11·09	15·37	
Available sugar per cent. ..	13·88	14·13	13·47	11·65	11·09	9·94	
3. Weight of fresh canes in lbs.	148–8	128–0	144–0	143–0	142–8	140–0	Date of analysis :
Dryage per cent.	..	3·13	3·99	6·47	8·59	9·28	Last week of January 1938.
Brix (corrected)	22·11	22·51	22·78	23·45	23·72	23·92	Date of planting of cane :
Glucose per cent. ..	0·21	0·48	0·932	2·033	3·076	3·75	November 1936.
Pol. sucrose per cent. ..	21·0	21·2	20·5	20·0	19·1	18·3	Number of canes in each
Purity	94·97	94·17	90·01	85·29	80·52	76·50	bundle = 26.
Reducing-sugar ratio ..	1·0	2·264	4·546	10·165	16·105	20·49	
Available sugar per cent. ..	14·48	14·34	13·37	11·87	10·14	8·87	

TABLE I—*Contd.*

	0 hours	24 hours	48 hours	72 hours	96 hours	120 hours	Remarks
4. Weight of fresh canes in lbs.	116–0	101–8	102–0	114–12	120–0	109–8	Date of analysis: Last week of February 1938.
Dryage per cent.	..	2·2	3·91	6·31	7·92	10·05	
Brix (corrected)	22·38	22·88	23·13	23·46	24·13	23·98	Date of planting of cane: November 1936.
Glucose per cent. ..	0·137	0·209	0·758	1·846	2·999	3·608	
Pol. sucrose per cent. ..	21·2	21·65	21·15	20·0	19·5	18·3	Number of canes in each bundle = 25.
Purity	94·73	94·64	91·44	85·25	80·81	76·32	
Reducing-sugar ratio ..	0·646	0·965	3·584	9·23	15·38	19·72	
Available sugar per cent. ..	14·77	14·94	14·01	12·06	10·60	9·02	
5. Weight of fresh canes in lbs.	118–8	105–0	128–0	121–8	110–0	128–8	Date of analysis: Last week of March 1938.
Dryage per cent.	..	1·91	3·13	4·73	7·7	8·57	
Brix (corrected)	19·52	19·85	20·32	20·75	20·99	21·59	Date of planting of cane: November 1936.
Glucose per cent. ..	0·291	0·350	0·932	1·655	2·399	3·199	
Pol. sucrose per cent. ..	18·50	18·65	18·0	17·70	17·20	17·05	Number of canes in each bundle = 28.
Purity	94·79	93·96	89·02	85·29	81·94	78·96	
Reducing-sugar ratio ..	1·573	1·877	5·178	9·350	13·948	18·762	
Available sugar per cent. ..	12·64	12·68	11·62	10·65	9·53	8·58	

TABLE II.

Station—Mandya

Record of monthly means of maximum and minimum temperatures and relative humidity

	April 1937	May 1937	June 1937	July 1937	August 1937	September 1937	October 1937	November 1937	December 1937	Januray 1938	February 1938	March 1938
Maximum	94°·4	96°·1	88°·3	83°·7	85°·5	85°·6	82°·7	80°·3	81°·5	84°·4	89°·2	95°·0
Minimum	70°·9	71°·0	69°·9	69°·9	70°·0	69°·6	69°·6	67°·2	61°·0	60°·1	68°·0	71°·1
Relative Humidity%	85	81	81	84	82	85	86	87	82	85	69	71

humidity are the important factors in determining dryage, it is necessary to examine these climate factors of the locality. Table II is therefore drawn up to show the monthly means of maximum and minimum temperatures and relative humidity so kindly supplied by the Government Meteorologist, Bangalore.

The figures given in Table II cover a period of 12 months. The maximum temperature recorded is 96°.1 F. during the month of May. With the exception of February and March the relative humidity is never below 81 per cent. during the rest of the period of the year. During these months the percentage of relative humidity varies from 81 per cent. to 87 per cent. It can therefore be concluded that the desiccating power of the atmosphere of the locality under consideration is not so intense as to cause excessive dryage in harvested canes exposed to atmosphere. This conclusion is borne out by examining the rate of dryage, an abstract of which (from Table I) is given below:—

TABLE III

Loss of weight per cent.—Original weight

Month of analysis	After 24 hours	After 48 hours	After 72 hours	After 96 hours	After 120 hours
October 1937	1·59	4·0	6·59	8·39	..
December 1937	1·59	3·22	3·84	4·81	..
January 1938	3·13	3·99	6·47	8·59	9·28
February 1938	2·20	3·91	6·31	7·92	10·05
March 1938	1·91	3·13	4·73	7·70	8·57
Average	2·08	3·65	5·59	7·48	9·30

From the data presented above, it is seen that the average loss of weight after 24 hours is 2.08 per cent. and after 120 hours 9.3 per cent. It may be said in general that an exposure for 24 hours results in a loss of about 2.0 per cent. in the weight of cane. It would be instructive to compare these figures with those reported by Haldane

(1933) in upper India. During the crushing season, that is from November to May, the maximum temperatures have been shown to vary from 75° F. to 101° F. and the relative humidity from 29 per cent. to 61 per cent. The loss of weight of seven varieties of cane examined, varied after 24 hours of exposure from 2.5 per cent. to 7.0 per cent. and after 120 hours from 10.54 per cent. to 17.94 per cent. Though these figures are not strictly comparable with the figures obtained for the Mandya area, still comparing the comparatively dry condition of the atmosphere of Northern India during the cane season with the high humid state of the Mandya area, it may be said in general, that climatic conditions prevailing at Mandya are not such as to cause high dryage. Supposing that 48 hours elapse between harvesting and milling, a loss in the weight of cane of 3.65 per cent. observed in the present instance, would indeed be a negligible quantity. Therefore the loss in the weight of cane due to dryage need not be a source of anxiety either to the ryots or to the authorities of the Sugar Factory.

Deterioration

The rate of deterioration may be measured by noting the decrease in purity of the juice. The units decrease in purity after intervals of 24 hours, 48 hours, etc., are given below :—

Table IV

Month of analysis	After 24 hours	After 48 hours	After 72 hours	After 96 hours	After 120 hours
October 1937	1·42	3·87	10·83	14·74	16·75
December 1937	0·21	2·52	10·35	12·65	14·38
January 1938	0·80	4·96	9·68	14·45	18·47
February 1938	0·09	3·29	9·48	13·92	18·41
March 1938	0·83	5·77	9·50	12·85	15·83
Average	0·67	4·08	9·97	13·72	16·77

From the above statement it is seen that the decrease in purity in 24 hours is about 0.7 units and then deterioration proceeds very rapidly. From the average decreases

given under Table IV, the following statement is prepared to show at what period the rate of deterioration is at its maximum.

TABLE V

Showing the rate of deterioration at intervals of 24 hours

Between 0–24 hours	Between 24–48 hours	Between 48–72 hours	Between 72–96 hours	Between 96–120 hours
0·67	3·41	5·89	3·75	3·05

It is clear from the above figures that the rate of deterioration is maximum between 48 and 72 hours—a fact of supreme importance to the miller.

The importance of the decrease in purity can more readily be appreciated by considering the yields of available sugar from cane when 24, 48, 72, 96 and 120 hours elapse between cutting and milling. The following figures are computed on the basis of 70 per cent. extraction:—

TABLE VI

Available sugar per cent. cane

Month of analysis	Fresh cane	After 24 hours	After 48 hours	After 72 hours	After 96 hours	After 120 hours
1	2	3	4	5	6	7
1. October 1937	12·89	12·34	12·20	10·11	9·0	8·17
2. December 1937 ..	13·88	14·13	13·47	11·65	11·09	9·94
3. January 1938	14·48	14·34	13·37	11·87	10·14	8·87
4. February 1938 ..	14·77	14·94	14·01	12·06	10·50	9·02
5. March 1938	12·64	12·68	11·62	10·65	9·53	8·58
6. Average	13·73	13·69	12·93	11·27	10·05	8·92
7. Difference (average) of 3, 4, etc., from 2 ..	..	0·04	0·80	2·46	3·68	4·81
8. Average differences between 2 and 3, 3 and 4, etc. ..	..	0·04	0·76	1·66	1·22	1·13

It is seen from the above statement that the average loss in available sugar due to a delay of 24 hours in milling is only 0.04 per cent. which is very slight. After 48 hours the loss is observed to be 0.80 per cent. and in 72 hours the

loss suddenly shoots up to 2.46 per cent., which is really very serious. Comparing, however, the rate of fall during different intervals as given under column 8, it is seen that the rate of fall of 1.66 per cent. is maximum during the interval between 48 and 72 hours.

It is therefore clear from the above considerations that a maximum amount of 48 hours is the safest interval that can be allowed to elapse between harvesting and milling.

Usefulness of the Present Data in the Jaggery Manufacture

The experimental data obtained in the present investigation can also be made use of to throw some light on the problems arising in the manufacture of jaggery. Generally the jaggery manufacturer harvests only so much of cane that he can consume the same day. However, the writer has come across with many instances where the harvested cane is left over for days awaiting milling. For the guidance of such manufacturers, a few observations may not be out of place.

The question of dryage and the consequent loss in tonnage are not of primary importance to the jaggery manufacturer. But dryage has a direct bearing on the percentage of extraction. Partially dried canes yield less quantity of juice than a fresh sample. The following table is therefore drawn to show the influence of dryage on extraction as well as on total solids of the juice.

Table VII

Showing the effect of dryage on extraction per cent. and on total solids of juice

	Fresh cane	After 24 hours	After 48 hours	After 72 hours	After 96 hours	After 120 hours
Dryage per cent.	..	2·2	3·91	6·31	7·92	10·05
Extraction per cent. ..	62·66	62·22	60·3	57·08	56·5	54·0
Brix at 17°·5 C. of extracted juice	22·38	22·88	23·13	23·46	24·13	23·98

From the above statement it is seen that as the cane dries more and more, the amount of juice extracted goes on diminishing. But the loss of juice is to a certain extent compensated for by the increase in total solids of the juice.

More serious than the loss of juice is the loss in the quality of juice extracted from canes left over after harvest. The reducing sugars rapidly increase at the expense of sucrose as can be seen in the following table which has been abstracted from the primary data given in Table I.

Table VIII

Showing the average percentages of glucose, sucrose and reducing sugar ratios

Time interval	Fresh cane	After 24 hours	After 48 hours	After 72 hours	After 96 hours	After 120 hours
Glucose per cent.	0·201	0·353	0·822	1·896	2·701	3·31
Sucrose ,, ,, ...	19·90	20·08	19·71	18·94	18·41	17·70
Reducing-sugar ratio ..	1·01	1·758	4·171	10·01	14·68	18·69
Increase per cent. of glucose ..		76·1	309·0	843·0	1244·0	1547·0

From the above statement it is evident how rapidly the glucose content increases by delay in milling. In the course of 24 hours the glucose content increases by 76.1 per cent. and in 48 hours by more than 300 per cent. over what was present in the fresh juice. In the manufacture of jaggery, the one single factor that determines the quality of the product is the amount of glucose present in the juice. The presence of a large quantity of glucose in jaggery ruins its keeping quality. In the rainy season such a product begins to sweat and run. It is rarely possible with 1.896 per cent. of glucose in the juice of a 72 hour-exposed-cane to have the massecuite set in the moulds. It can therefore be concluded that in the manufacture of good jaggery, canes should be milled within 24 hours after harvest.

Development of Acidity in Deteriorating Canes

It has already been pointed out that a high rate of increase of glucose is one of the most undesirable properties of cut cane exposed to weather. Coincident with this property, a high rate of increase of acidity seems to be another characteristic. The following table shows the acidity of juice of fresh cane and of juice of canes exposed for varying periods:—

Table IX

Showing c.c. normal acid per 100 c.c. juice with reference to phenolphthalein.

Fresh cane juice	After 24 hours	After 48 hours	After 72 hours	After 96 hours	After 120 hours
1·08	1·44	1·68	1·81	1·88	1·92

The above statement is self-explanatory. When liming is done with no reference to the amount of acid present in the juice, inversion during boiling proceeds at a faster rate in the case of juice from stale canes than in that of the juice from fresh canes, and consequently the quality of the product suffers. Considering all the facts discussed above it seems advisable that as little time as possible should be allowed to elapse between harvesting and milling in the case of jaggery manufacture, and a maximum period of 24 hours seems to be the limit to which the canes may safely be allowed to lie over after harvesting.

Acknowledgment

The writer takes this opportunity to express his grateful thanks to Mr. K. Bhima Rao, Agricultural Chemist, and Dr. B. T. Narayanan, Biochemist, for the keen interest they have taken in this investigation and for permission given to the writer to publish this article.

REFERENCE

1. Haldane, J. H., 1933, *Int. Sugar Jour.*, 35, 140, 142.

The Rice Mealy Bug in South India

By

Dr. T. V. Rama Krishna Ayyar, B.A., Ph.D.

Retd. Government Entomologist, Madras

Introduction

In some of the rice areas of South India especially along the delta areas of the Tanjore District rice (paddy) plants, during the early stages of their growth are frequently found subject to the attacks of a disease known in the local vernaculars as *Soorai, Senchoorai, Dumpa tegulu,* etc., and for some years past reports have often been received from different paddy areas of serious damage caused to the paddy crop by this disease. It has also been ascertained that the major causative agent of this complaint is a sap-sucking bug found in large numbers attached to infected plants which are characterised by their stunted growth, gradual yellowing and withering.

In this paper an attempt is made to present a short general account of the nature and extent of the disease and the more important features in the bionomics of the insect agent and to point out the economic aspect of the disease to the rice cultivator in South India.

2. Nature of the Disease

The existence of this disease in any paddy area is generally detected by the presence of young paddy crops in isolated patches of stunted and sickly plants gradually turning yellowish brown and beginning to wither. From a distance it would appear to the casual onlooker as though the plants have suffered from severe drought or some food-deficiency in the soil; but in most cases a closer examination of the diseased plants reveals the presence of numerous smooth reddish-white soft insects attached to the plant stem concealed under the covering leaf-sheaths. It is therefore evident that the major cause of this disease is the mealy bug, which sucks up the plant sap and prevents the healthy

growth of the plant. Of course, it is possible that in some cases other agencies such as severe drought, insufficient nutrition and fungoid or bacterial infestations might bring about such results as stunted growth and yellowing or drying up of the foliage; the writer has also come to know that in one case in Burma such results have been brought about by sulphur deficiency in the soil. In parts of Malabar the writer has seen such conditions without any insect infection. However, in most of the cases examined in many different parts of South India, the disease described above has been found closely associated with the presence of the sap-sucking mealy bug.

In the infested fields, the disease at first shows itself by the presence of small roundish or oval patches of stunted fading plants in different parts of the field and these patches cover only a few square feet each enclosing a few plants, but gradually the infection spreads around the original infected nuclear area enclosing more diseased plants until, in some bad cases, extensive ovoid or circular *Soorai* patches show themselves conspicuously. A detailed examination of a patch infested by mealy bug would show the different stages of attack in the plants; in some extreme cases the bugs will be found in colonies of hundreds having almost completely killed the shoot, while in others the tender earhead enclosed in a diseased leaf-sheath will be found completely sucked up and turned to chaff with a dirty white mealy covering on the surface; and in some others the diseased chaffy earhead will be found struggling to emerge out of the sheath only to fade and wither. The diseased parts of the plants will be found sticky to the touch due to the flow of honey dew secreted by hundreds of bugs; often a disagreeable odour can be felt while handling badly diseased plants. In almost all such plants the pest can be found in large numbers and in different stages of growth. Finally, the infested shoots fade and gradually die away before the other healthy uninfested plants in the field are in ears and approach harvest time. In some cases the pest

is also noticed in the nurseries; infested seedlings show a characteristic curling up and fading which are generally overlooked by the lay farmer at this stage, since he generally expects the disease only in the planted fields.

3. Distribution and Early Records of the Disease in India

Soorai disease on rice has been known in South India for over two decades. The writer first noted the disease in the Coimbatore District as early as 1907. It is now known to occur in Tanjore, South Arcot, Trichinopoly and parts of Coimbatore District under the name *Soorai* or *Senchoorai*; in the Northern Circars the disease does occasionally occur, though not to such an extent as in Tanjore or South Arcot and is known in some tracts as *Dumpa tegulu.* Recently, the disease was noted by the writer in parts of South Malabar where it made its first appearance in pest form in some of the broadcasted dry paddy lands. The writer has come to understand that the disease does exist in Mysore and that it sometimes appears as a serious pest on dry paddy land. It is also reported to be found in parts of Burma and that in some cases it has not been possible to find out the real causative agent or incriminate the mealy bug alone. In the Punjab and Ceylon this disease does not appear to be prevalent.

The first actual record of this disease in Northern India goes back to the year 1907 when "a widespread disease of rice associated constantly with this insect (mealy bug)" was noted in Tirhoot and Bihar and the following graphic description of the disease by Lefroy (Lefroy, "Indian scale insects," *Mem. Department of Agriculture,* Entomological Series II, 1908, page 128) almost exactly corresponds with our experience and observations of *Soorai* in South India.

"The bug occurred in numbers under the sheathing leaves and on the stems; the plants, both seedlings in the bed as well as young and old plants in the fields, became yellow

and withered. The insects were found inside the sheathing portion of the leaf and until this was opened there was no indication of the occurrence of the insect." As far as the writer is aware the first published record of this disease from South India is by Newstead[1] and the writer[2] in 1917, the former in his systematic paper on Coccidæ when he determined the insect from material submitted by the writer from his collections made in Tanjore in 1914, and the latter in the *Report* of the Second Entomological Meeting held at Pusa when discussions were held on the different pests of paddy in India. The disease has, however, come to prominence only within the last fifteen years, since neither Lefroy nor Fletcher refers to this insect in their books on Economic Entomology. Later, references to the disease and the insect chiefly occur in the systematic and economic papers[3] of the writer published from the year 1919 up to 1933. Among these, special attention may be invited to the Crop-pest Calendars of 1922 wherein this insect and the disease are noted and figured; latterly in his papers on the " Coccidæ of South India" (1930) and in his bulletin on "Paddy Pests in South India " (1932) a brief account is given of the insect and the damage caused. During the past few years it has also had a place in the periodical reports of the Madras Government Entomologist.

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[1] Newstead, "Observations on scale insects", *Bull. Entomological Research, London,* 1917, VIII, p. 126.

[2] Ramakrishna Ayyar, *Report of the Second Entomological Meeting, Pusa,* 1917, p. 178.

[3] Ramakrishna Ayyar, " A contribution to our knowledge of S. Indian Coccidæ," *Pusa Bulletin,* 1919, No. 87, p. 41; " Some Insects recently noted in S. India," *ibid.,* 1920, No. 101, p. 13; "An Entomologist's Crop Pest Calendar for the Madras Presidency," *ibid.,* 1922, No. 131, p. 5; " List of important crop pests of S. India," *Bulletin 86, Department of Agriculture, Madras,* 1923, p. 3; " Coccidæ of S. India," *Pusa Bulletin,* 1930, No. 137, p. 59; " Insect pests of paddy in S. India," *Bulletin 25, Department of Agriculture,* 1932, p. 7; "Important insect problems *re.* cultivation of Rice in S. India," *Agriculture & Livestock, Delhi,* 1933, III (4), p. 349.

4. The Causative Agent of "Soorai" Disease

As has already been stated above, *Soorai* disease of paddy in South India is very commonly due to the work of sucking insects invariably found associated with the diseased plants. The sucking insects in this case are mealy bugs. These belong to the insect order Rhynchota (includes all insects known as bugs) and are members of the family Coccidæ (scale insects and mealy bugs). With regard to the correct identity of the *Soorai* mealy bug, it is unfortunate that there has been some confusion in its nomenclature till very recently. In 1917, Newstead, in his paper referred to, identified the insect found in the material submitted by the writer in 1914 as *Pseudococcus sacchari,* CK11. Green,[4] on the other hand, determined on the basis of the material sent on paddy from Bihar by Lefroy in 1907 as *Ripersia sacchari.* Recent studies on further material on paddy from South India have so convinced the famous coccidologist, Green that he has recently found out that the commonest mealy bug found associated with paddy *Soorai* in India is neither *Pseudococcus sacchari*, CK11. nor *Ripersia sacchari*, G., but a species quite different from either of the two; he has also expressed that the insect from Bihar which he examined years ago is not *R. sacchari* G. Green has, therefore, described[5] the *Soorai* bug of paddy as a new species under the name *Ripersia oryzæ*. Thus all previous references to the insect associated with paddy *Soorai* under the names *Pseudococcus sacchari* CK11. or *Ripersia sacchari*, G. must be considered to refer to this newly described form *Ripersia oryzæ,* Gr. The figure marked *Ripersia sacchari* in Lefroy's colour plate XII, *Entomological Memoir,* Vol. II, is, therefore, *Ripersia oryzæ* Gr. In the writer's recent papers (1932 to 1933) the correct name is given. It may be added by the way that both *Pseudococcus sacchari* CK11

[4] Green, E. E., "Indian Scale Insects," *Mem. Dept. of Agriculture, India,* 1908, Ent. Ser. II, p. 25.

[5] Green, "Two new mealy bugs from India," *Ann. Mag. N. H.,* 1931, VII (10), p. 557.

and *Ripersia sacchari* Gr. are two well-known mealy bugs which attack sugarcane in many areas—especially so is the case with the former, which is more recently known by the name of *Trionymus sacchari* CK11.

5. General Features and Life Habits of the Rice Mealy Bug (*R. orzæ* Gr.)

The *Soorai* mealy bug, in all general characteristics and habits, is similar to most other mealy bugs. The body of the adult female is soft and fleshy with a more or less white powdery (mealy) waxen covering. The insect is wingless. It will be generally found fixed to the plant. It measures about 1/12″ in length; the size often varies and it may be shorter or longer than 3 mm. In shape, it is oval or elongate oval with the anterior region rounded. The general colour is whitish red. For minute details Green's description may be referred to. The life of the insect is spent on the plant itself and the different stages of development of the creature may be seen on the plant at the same time. As in the case of most mealy bugs, the male insect is a tiny delicate two-winged creature which is very rarely noticed. Reproduction in this mealy bug is probably to a very great extent by "Parthenogenesis" as has been noticed in the other closely allied insects. As regards the different stages in the life-history of the insect and their morphological features and habits there is hardly any difference between these larvæ and those of other mealy bugs. On the average, the gravid female insect lays any number of eggs from ten or twelve to two or three hundred during a period of five or six days. The eggs are elongate oval in shape, having a yellowish or reddish white tinge; they are generally laid singly one after the other on the plant surface and in this process they often become connected at the ends in the form of a chain of beads. The incubation period of the egg is in some cases so short (only a few hours) that it is not improbable that, in addition to the existence of parthenogenesis in these insects they are also ovoviviparous,

at least during certain seasons. The young larvæ are active and continue to be so until the last moult after which if they are females they fix themselves to the plant surface for life and grow in size. The male larvæ gradually develop wings after the first few moults and emerge as small active flying creatures only to die in a day or two before which period they generally perform their sexual function. The whole life-history of a female insect occupies three to four weeks on the average but this may vary according to seasonal changes. It may be pointed out that it is the female insect which is found in thousands causes direct harm to the paddy plants.

6. Alternate Host Plants of the Insect

Recent observations have shown that this insect feeds on a variety of common grasses besides paddy. The following have been so far noted as alternate host plants. *Leptochloa polystachya, Eragrostis interrupta, Panicum colonum, Fembristylis miliacca, F. argentia, Eriochloa polystachya, Imperota arundinacea, Andropogon annulatus, Apluda varia, Cynodon dactylon, Panicum repens, P. javanicum, Ischacmum craliare, Juncellus Pygmacus, Cyperus rotundus* and *Eleusine coracana* (Ragi).

7. Natural Enemies of the Insect, etc.

As in the case of mealy bugs in general small chaloid wasps and flies have been noted to parasitise both the eggs and the later stages of the insect but so far none of these has been noted to exercise any effective control as a natural enemy. In dry patches ants also visit the mealy bug colonies and act as very effective distributing agents of the pest. One or two lady bird beetles (*Scymmus* sp.) are also occasionally found as predators on the mealy bugs. Among fly parasites the drosophilid *Gitonides perspica,* Kb. and the chloropid *Lencopis luteicornis,* M. have been noted on this and other South Indian mealy bugs. It is, however, possible that further studies might give us some idea as to whether

any of these natural enemies are capable of being utilised in controlling the pest.

8. Factors Influencing the Incidence and Dispersal of the Pest

It has been noticed that severe drought during the growing periods of paddy often brings up the infestation markedly; this has been confined more or less by the outbreak of this pest very recently in Malabar where the monsoon rains were late and some of the early sown fields suffered from drought. To a certain extent bad drainage and to a much greater extent want of sufficient plant food in the soil also bring about the pest infestation. The wide-spread outbreak of the pest is also aggravated by the peculiar advantages commanded by the insect with regard to rapid multiplication and wide-spread dispersal. Reproduction by parthenogenesis assisted by the enormous number of eggs laid and the short life-cycle of the insect help its rapid multiplication under favourable conditions. Similarly the presence of numerous host plants, water, wind and human agencies considerably aid the insect to distribute itself easily into extensive and distant areas in spite of the fact that it has no wings to fly. The insect is especially safe living under the enclosing leaf-sheaths free from the easy reach of enemies. In addition to these apparent factors, it is quite possible that further studies might help us in getting at more correct views of the habits of the pest and the more important factors which influence its development or control. The writer feels that meteorological conditions play a very important part in this matter.

9. Control Measures

There is hardly any doubt that this insect has, within the past few years, come into prominence as an important pest, especially, in the Tanjore delta. As in the case of some of the borer pests, mechanical methods of control like spraying, bagging, etc., are not useful in the case of this

insect also. In the case of such pests which are invisible from outside prophylactic methods alone can be safely relied on as economic propositions. Some work has been done in these directions and the results have not as yet proved encouraging. Destruction of all grasses in which the insect breeds sufficiently early, proper examination of seedlings and elimination of unhealthy seedlings before transplanting and helping the vigorous growth of the plants by proper manuring will considerably minimise the ravages of this pest. Of course, prompt attention to first attacked plants and first appearing diseased patches might also help in preventing the spread of the pest, but is doubtful whether this will be found a practical proposition in extensive areas. So far no special variety of paddy has shown any marked immunity to this pest but it is possible, trials in this direction may also give us some helpful data as to varietal immunity.

10. Suggestions for the Future

Now that some general work has been done to get an idea of the fundamental nature of the disease and the insect agency, the writer feels that further work on this subject, especially on the following aspects, might give some encouraging clues. (1) A detailed account of the life-history, nymphal stages, methods of reproduction and generations in the year of the insect; (2) a similar study of its natural enemies and their prospective effectiveness for utilisation; (3) cultural and other factors, especially meteorological, which influence pest incidence; (4) trials of fertilisers to help vigorous growth of plants as a preventive; (5) observation in incidence of pest on different strains of paddy to find out a pest-free variety if possible; and (6) trials in mechanical measures such as treatment of seedlings before planting, attention to other host plants and treatment of irrigation water with insecticides, etc.

In conclusion, it must be added that though the pest is one which is rather difficult to deal with considering the peculiarly favourable conditions under which it attacks the

crop, further investigations on the lines indicated above might help us though not entirely to exterminate the pest, at least to reduce considerably the damage it is causing to an important staple food crop like paddy. In the opinion of the writer it is also not unlikely that intensive studies on the disease and the associated insect might even reveal whether this bug plays an additional part as vector of any virus or fungus diseases which may be found, or which may be introduced into paddy from other food plants; for, some workers like Smyth and Brunner have hinted that the notorious sugarcane mealy bug—a very close ally of the *"Soorai"* bug and for a long time considered to be the same, *viz., Trionymus* (*Pseudococcus*) *sacchari,* CK.—plays the part of a vector of such diseases as mottling, mosaic, etc., in sugarcane.

A Rat-Trap for Cocoanut Plantations

By

S. V. Venkatarayan, B.A.

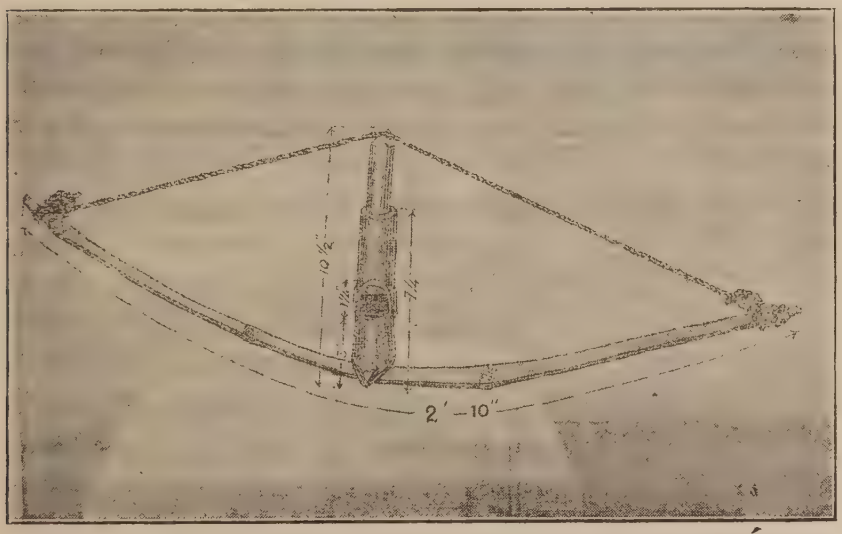
Senior Assistant Mycologist, Department of Agriculture, Mysore

The tree rat is so much of a nuisance in many cocoanut plantations that any or all of the available methods of exterminating it are seldom satisfactory. The common ones are the employment of the poisoned bait, trapping, tarring the stems, fixing up of tin or galvanized iron collars round the stems, employment of the mouse typhus bacillus, and the braying of donkeys. The last one is probably a superstition. It is not the purpose of this note to assess the real worth of each measure, but only to suggest that all methods may be given a fair trial.

Quite recently an ingenious method of trapping this pest has come to the author's notice. It looks so simple that the surprise is that it has not become more widely known. It consists in the employment of a bow and piston made out of easily available materials. This may perhaps be considered to be a relic of the ancient warriors' bow and arrow. This

is being used in and near Calicut in Malabar District. It is found effective against squirrels and tree rats. A number of these traps may be set up on as many trees simultaneously.

The trap consists of a bow made of split bamboo, about 1⅛ in. wide and about 3 ft. long tied up with coir rope (see Fig.). In this is placed a bamboo piston, grooves being cut at the base of the cylinder and at the free end of the wooden piston rod to fit the bow and string respectively. The overall length of the cylinder and piston fixed in position in the bow



is about 10 in. The internal length and diameter of the cylinder, which is closed at one end, are 6¼ in. and 1 in. respectively. About 2 in. from the closed end is a slit, the "trap-door" about 1¼ in. long, cut in a sloping manner, and going half-way down the side of the cylinder to the bottom end of the slit. Four holes, two at the top and two at the bottom of the slit, are pierced through the cylinder; a bit of string runs through all of them and is knotted tightly. As a result of this there are seen two parallel bits of string in the cylinder, one at the top and another at the bottom of the trap-door. The piston rod which is slightly longer than the cylinder rests on the top piece of the string when fixed in

position in the bow, while the bottom piece of the string protects the bait as it were. The bait is placed at the bottom of the cylinder, and can be reached by the rat only after gnawing the string below the trap-door. The rat in trying to reach the bait cuts the string with the result that the piston closes in on it with a startling suddenness and jams its head.

The trap can easily be made at a low cost. It sells at two annas each, but when made in large numbers, it may not cost even so much.

When placed on the tree among the bunches of fruits the trap is not conspicuous. But it has to be examined and cleaned daily after use. The only disadvantage of this trap in common with many other traps is that only one rat can be trapped at a time.

Improvement of Crops in Mysore

(*A Review of Twenty-five Years' Work*)

By

Dr. V. K. Badami, L.Ag., Ph.D. (Cantab.)
Deputy Director of Agriculture in Mysore

(*Continued from the previous issue*)

6. *Potato.*—The high-land parts of Bangalore and Kolar Districts are well suited for growing successful crops of potato. At one time over 10,000 acres were under this crop. In Kolar, mulberry displaced it to some extent. Small areas are often found as a dry crop in Shikaripur also. Large quantities were exported to Madras and Colombo. The rapid extension of potato cultivation on the Nilgiris and the dumping of Australian and Italian potatoes on Colombo have greatly affected our market. Ring disease is a great check to potato cultivation in Mysore. Dr. Leslie C. Coleman worked on this disease and suggested that the only effective remedy lay in the breeding of disease-resisting varieties. Once the ring disease—*Bacillus solanacearum*—got into the land and contaminated it, even if the field were put under

other crops for several years, crops of potatoes grown later get affected with this bacterial disease. By careful selection of disease-free seed and lifting the crop a little before it is fully ripe, the losses caused by the bacteria can be mitigated to some extent.

The original "*Nati gadde*" is an irregular shaped tuber with an yellow flesh. It is grown in two seasons, once in May to October, during the monsoon and as a cold weather crop in November to March. During the first season the crop is often grown in light dry soils with the help of rain alone. During the cold season several well-known English varieties are grown mixed up under the collective name of "*Ricketts gadde*". They were introduced between 1885 and 1895. A very large number of European and American varieties were tested by the Government Gardens before 1908. The Agricultural Department have been testing them since then. These varieties have done well for a season or two and succumbed to ring disease. Large quantities of Italian potatoes were imported by the trade yearly to replace the local variety. For some time the method was promising and successful. At present *Great Scott* and *British Queen* are the only two varieties grown in some places. The bulk of the crop on an area of about 5,000 acres is either the local yellow variety or *Ricketts*.

Recently a large number of varieties were secured from Darjeeling and tested both in the monsoon and cold weather. They are very well known in Europe as *Arran Banner, Arran Chief, Ben Cruchan, Majestic, Bishop, British Queen, Darjeeling, Factor, Great Scott, Kirrs Pink, President, Talisman, Up-to-date* and *Windsor Castle*. In June planting, *Great Scott* yielded over 360 maunds or 9,000 lbs. to the acre and *Arran Chief, British Queen, Talisman* and *Windsor Castle* have yielded over 6,000 lbs. to the acre. During the cold weather *Arran Banner, Great Scott, President* and *Majestic* have given good yields. Seed Farms are necessary at Hosakote, Devanahalli and Sidlaghatta to multiply and distribute good seeds. Once in four or five years a fresh consignment may be got from Darjeeling till a hill station

seed farm is opened somewhere on Kalhathigiri or the Baba-budans.

In 1922 there was a free blooming of potatoes in Mysore. Some ripe berries were obtained and over 11,000 seedlings were raised, probably for the first time in India. Most of the plants in the *Ricketts* variety produced seedless berries. It was only in the local variety that the seed was secured for breeding work. The yellow tuber of the local variety showed itself to be highly heterozygous. Size and shape of tuber varied much. Colour of skin and flesh ranged from pink to white. The yielding capacity also differed from plant to plant. Very heavy yielding strains of over 10 tons to the acre were isolated. When some of them were tested in the areas where ring disease is common, they got wiped out. Much of the material was lost during the hot summers of 1924 and 1925. At present these four varieties, B.Q. 39, Sel. 284 H., Sel. 384 and 5 B.T. are found to be highly resistant to ring disease giving good yields.

The climatic conditions of Bangalore are well suited for conducting breeding work. It seems possible to raise varieties which would give twice the yield of our present maximum crops of 400 maunds to the acre. Indications are that it is even likely that strains may be secured to grow successfully at lower elevations or even in the hot fertile plains of South India.

Since 1930 a large number of fresh seedlings have been raised and tested. Very recently a Mysore student studying at Kiel in Germany, collected about 67 varieties of potatoes and sent them over here for trial. With the help of the Mycologist those which are known to be highly susceptible to Wart disease were eliminated. While the area under it is dwindling, the use of potato as a common food is increasing. Though the "Alternaria" disease and the "Epilachna beetle" are kept under control by spraying and dusting, a situation might soon arise converting Mysore from an exporting country into an importing one. There is an immediate need for efficient seed farms for raising healthy tubers for distribution.

7. *Cotton.*—There are two tracts in Mysore fit for growing Indian types of cotton. The largest area, of about 300,000 acres of "Black Cotton Soil", is situated to the north-east of the Bababudan Hills. The main variety grown is *G. herbaceum* (*Sannahatti*) and this comes under the commercial classification of 'Kumptas' of Bombay. About 120,000 acres used to be grown with this crop formerly but now owing to trade depression and competition of other commercial crops like groundnut, the area has dwindled to about 80,000 acres. A small tract of about 5,000 acres of block cotton soil, lying to the north-east of the Nilgiris, is found in the Mysore District. Annually about 2,500 acres of *Nadam* cotton, *G. obtusifolium,* are grown in this tract. In parts of Hassan, Chitaldrug and Shimoga about 5,000 acres of an acclimatised type of Upland American cotton locally known as *Doddahatti* is grown as an early crop on red soils. This type was exported as *Banavar* cotton. The area of black cotton soil is limited and any extension in cotton cultivation should take place on the red soils either as rain-fed crops or as irrigated crops. Annually about 50,000 bales of cotton are now being used by the cotton mills in Mysore and the local production is quite inadequate to meet this demand successfully. If a suitable American type of cotton which can withstand "Red Leaf" disease and drought is evolved and successfully cultivated on the red soils, it seems quite possible to meet the local demand and, in addition, put on the Bombay market about 100,000 bales of good long staple cotton.

Mysore cottons were studied in 1917. The two main types were found to be *G. herbaceum* (*Sannahatti*) and *G. obtusifolium* (*Nadam*). *Sannahatti* was found to be a mixture of many types. Some of them like the naked seeded ones were found to be highly heterozygous in nature. A few strains were found to be more productive than others. In 1915 a large number of plants were selected round about Davangere. They were studied in the laboratory for quality and ginning percentage. The best ones were grown in pure line cultures. S. 69, which has now practically spread over the whole of the northern cotton area in Mysore, was isolated

out of these cultural line tests. It has a good yield and is superior to local cottons. In some areas it takes a slightly longer time to mature but it has come to stay as the main commercial type in Mysore. Pure seeds are being obtained by ginning on the Government Farm at Babbur. The Co-operative Society at Maradihally has over 2,000 acres of this variety under its control to produce good certified seed. Attempts are being made to open some more centres in the cotton area for seed production.

In 1924, Mr. V. N. Ranganatha Rao, Senior Assistant Botanist, working at Babbur crossed *G. arboreum* with *G. herbaceum* to develop a variety to equal Broach cotton in quality and suitable for cultivation in Mysore. For this purpose he selected S. 69 having yellow corolla, fuzzy seeds and shallow broad-lobed leaf and crossed it with the *arboreum* type generally grown near temples having long white strong lint, red corolla, green seeds and deep narrow-lobed leaf. The colour of the corolla and the seed and the shape of the leaf of *G. arboreum* were dominant in F_1 generation. In the later generations selection for such useful characters as earliness, low fruiting branches, ginning out-turn and lint quality was pursued in the eight possible classes given by the different combinations of the dominant and recessive conditions for the corolla, seed and leaf characters. Many cotton workers in America had indicated that the chances of success were little in developing commercial types through interspecific hybridization. In the course of this work two valuable strains have been produced and the qualities of one of these, H. 190 are quite as good as *Broach Deshi* 8 or Surat 1027 A.L.F. It has a broad-lobed leaf, yellow corolla and green seeds, staple length of 7/8" to 1", ginning out-turn of 30%, good quality and class of lint spinning 32's to 35's, giving a test of 80 to 85 lbs. at 19's and with a good colour. The yields are nearly as good as those of the local *Sannahatti* but the strain is highly susceptible to wilt. The green colour of the seed is useful for identification in the field after the fruit opens. A large number of test plots have been laid out in the District to find out areas where this strain can be

safely distributed. Strain 19 has red flower and green seed which would enable the grower to easily distinguish it in the field from other cottons grown in the locality. It has a ginning out-turn of 30%, but, for other characters it has to be tested under field conditions. *Jayavant* and *Dharwar* No. 2 are highly resistant to wilt and give yields of seed cotton as good as those of S.69 or local *Sannahatti*, but the ginning percentrage is comparatively low.

An inferior varity of cotton belonging to *G. neglectum* locally known as *Bokda* is spreading into the Mysore cotton tract through Bellary District. It is a heavy yielder and has a high percentage of lint, but the lint is short and coarse. With a view to evolving superior varieties to replace this undesirable one, Mr. Ranganatha Rao crossed *Cernum* with *Nadam*. We have now promising long stapled strains with a high percentage of ginning. They are being tested for yield. Some of them are highly resistant to wilt. The most promising strains are *Nadam-like* 21–22 and *Nadam-like* 149–152. These crosses have given valuable material for further work on breeding wilt-resistant strains. A few strains are early ripeners and annual in their habit but require to be critically tested in the *Nadam* area of the Mysore District.

Improvement of *Dharwar-American* (*Doddahatti*) cotton was found necessary for extending cotton cultivation on the red soils. Many exotic *Hirsutums* were obtained and tested. *Columbia*, *Durango*, *Lone Star*, *Forlus Red Eye* and *Cambodia* were considered at one time to be promising. Local *Doddahatti* was found to be the best yielder. All the *Hirsutums* were badly attacked by the "Red Leaf" disease. The Peruvian tree cotton was found to be less subject to this disease. Mr. Ranganatha Rao crossed the local *Doddahatti* with the Peruvian tree cotton in 1919 to evolve better types of American cottons. In addition, he crossed *Bourbon* and *Cambodia*. Over 400 plant selections were made in Cambodia in 1921 and six of the best were selected in 1922. As none of them was useful the work was dropped. Seventeen plants raised from *Bourbon-Cambodia* crosses were also

rejected in course of time. By 1922, work on crosses between Peruvian tree cotton and *Doddahatti* was showing hopeful signs. In the F_3 generation about 35 plant selections were made. They were fairly free from "Red Leaf" disease and possessed good lint. Out of them Mysore-American M.A. IV and M.A. II were multiplied for test and distribution. Over a series of years, at several places M.A. II has given very good results and is likely to replace the local *Doddahatti* in the Banavar cotton area.

Breeding work on American cottons was conducted at Babbur with the help of occasional irrigation. The crops were sown in September along with *Sannahatti*. The yields were comparatively low. When seasonal sowing experiments were conducted, it was found that by sowing early in May or June, heavy crops could be secured. In order to test all the material available under rain-fed conditions near the Banavar area an outstation was opened on the Singapur Kaval, about 9 miles from Chitaldrug on the road to Holalkere. Many strains unsuited to dry cultivation were eliminated. It is found that M.A. II and local *Doddahatti* are about the best types suited to these localities. Selections from M.A. IV are promising and are under observation. Selections made in *Doddahatti* round about Arsikere are found to be better than those made near Davangere. Before distributing M.A. II seed on a large scale it seems necessary to make a large number of plant selections in local *Doddahatti* to secure and preserve the best strains for further work. The reputation of Banavar cotton requires to be revived and every attempt should be made to evolve a suitable type for the area and extend its cultivation. A large stretch of flat level land in Abbanaghatta Kaval within a mile and a half from the Arsikere Railway Station seems to be well suited for starting a first class cotton breeding station. A stream separates the red soil block from the deep black cotton soil area. There is sufficient water in the stream for irrigating a few acres of land. A central station here would give ample scope for breeding cottons for all conditions of soil. Arsikere being a railway station, will be within easy reach of Bangalore

to obtain laboratory help required. Babbur Farm and Singapur outstation would be useful for multiplying the seeds suitable for those areas. Irrigated types would be tested both at Babbur and on the Irwin Canal Farm.

As an alternative crop to sugarcane, cotton varieties were tested on the Irwin Canal Farm. In the first instance it was found that by sowing in May or June soon after the heavy rains a very good stand can be obtained. Yields of over 40 maunds of seed cotton have been obtained with M.A. II and Co. 2 cottons. The second sowing in September does not yield well. A large number of American cottons and Indian cottons were tested and it was found that the locality required a late maturing crop which would burst its capsules only after the heavy north-east monsoon rains. A crop of M.A. II sown in May and left over till May next has yielded well over 60 maunds in the experimental plots. A summer crop of groundnut followed by Co. 2 or M.A. II cottons will be a very good substitute for sugarcane. Cotton can even be successfully grown in the dry block also. Ultimately there is scope for growing at least 25,000 acres in this area and even with an average crop of 20 maunds to the acre it may be possible to supply our mills with 6 to 7 thousand bales of lint. Here again "Red Leaf" disease is present but the two varieties Co. 2 and M.A. II are fairly tolerant to it. A power mill has already been installed on the Irwin Canal Farm to gin the seed cotton under supervision for obtaining good seed for distribution.

The Indian Central Cotton Committee sanctioned a scheme for breeding strains of cotton to resist "Red Leaf" disease in February 1935 for a period of three years at an average cost of Rs. 2,814 per annum. With the staff provided by the scheme intensive work on the testing of well-known varieties and hybridization are in progress at Hebbal, Central Laboratories and on the Irwin Canal Farm. M.A. II and Co. 2 resist the disease to a great extent and in spite of the appearance of the disease during July to September rather heavily, the yields of seed cotton have been promising. *Gadag* 285, F_1, *Aslimoni*, *Uganda* and *Sea Island* are highly

susceptible to this disease. The season of sowing, the virulence of the disease and the yield of cotton seem to be correlated. No variety is quite immune to the disease. Over 380 crosses have been made between varieties and species to see if any set of complementary factors exist which when brought together would produce resistant or tolerant strains. Crosses between *Sea Island* × *Lone Star* and *Sea Island* × *Bourbon* are full of promise. They are being back-crossed to their parents to intensify the characters. It is very interesting to note that *Sea Island* cotton by itself has no vigour and is highly susceptible to "Red Leaf" disease but when crossed with other *Hirsutmus* the hybrids show remarkable vigour of growth.

A large collection of wild types of cotton have been made from all parts of the world and we have now at present *G. harknessi, G. armorianum* (with and without petal spots), *G. Davidsonii, G. Strutii, G. trilobum, G. Taitense, G. Darwini, G. tomentosum, G. Schlotzianum* and *G. Stocksii.*

In addition, a collection of all the important commercial Indian cottons also have been maintained. They represent the main types belonging to *G. arborium, G. obtusifolium, G. neglectum, G. indicum* and *G. herbaceum.* By soaking the seeds in water to the swelling point and gently cracking the hard-seed coat it was found possible to easily germinate the wild cottons. The stock of wild cottons have been multiplied and given to other workers also. *G. Strutii* and *G. tomentosum* have not yet flowered here. All the American wild cottons having 28 chromosomes freely hybridize with the cultivated forms having 26 chromosomes but the flowers of F_1 plants are sterile in general. Back-crossing with their respective parents has been a failure. But in some cases the pollen seems to be effective in these hybrids. Since the plants are very healthy and highly resistant to "Red Leaf" disease they will be fully utilised for a series of back-crosses. The interesting fact that comes out of this work is that the difference in the number of chromosomes between the Asiatic and American types of cotton does not seem to be the main cause for the failure in hybridization. There may be other

causes which require to be investigated. It was further noted that the wild American cottons did not hybridize with the Indian varieties of cottons though both of them have 13 chromosomes, haploid. While a large number of wild cottons with 13 chromosomes are in the new world, the cultivated forms of *Hirsutums, Barbadenses* and *Peruvianums* have 26 chromosomes. On the other hand, the only wild cotton of Karachi *G. Stocksii,* has 13 chromosomes and it has not been successfully crossed with the Indian cottons. The material now collected in Bangalore will afford much scope for workers in Cyto-genetics.

The red colour of the leaves in the "Red Leaf" disease has been found to be due to the pigment 'anthocyanin'. It is turned green by ammonia and again into red by hydrochloric acid. The pigment is usually found in the upper epidermis and often in the smaller bundles and secretory cavities. The actual production of red colour is preceded by the disintegration of the chloroplasts. The red colour usually appears in the epidermis invariably adjacent to the stomata, the guard cells remaining unaffected. They later, spread, coalesce and form patches. In badly affected leaves the disintegration of chloroplasts is complete. Attempts have been made to induce "Red Leaf" by physical injury to the plant with some success. Budding of different varieties on the same stock has shown that varieties have different degrees of susceptibility to "Red Leaf" and that the disease is not transmitted through the soil.

In the Laboratory, germinated and resting seeds, young seedlings, ovaries and pollen grains have been treated with X-ray to see if any new strains of utility could be evolved. Exposures ranging from 7½ minutes to 30 minutes have been made. The latter dose seems to be very near the lethal dose. There was a greater mortality in the germinated seeds. Suppression of branches, malformations of leaves and flowers were noticed in the treated material. Young buds, 2 to 3 mm. in diameter, were exposed for 2 to 4 minutes and they dropped off after a time. Pollen grains exposed for 2 minutes and dusted on emasculated flowers have set fruits. We have

been treating material sent to us from Coimbatore in this work. So far, no result of economic importance has been achieved. In case we can break down the number of chromosomes in the American types or secure successful crosses with Asiatic × American types, then X-ray will surely be an useful aid in cotton breeding work.

8. *Tobacco.*—In the north-eastern part of the State tobacco is grown on heavy irrigated soils in the cold season mainly for chewing purposes. In the Hunsur area Bettadapur tobacco is grown as a dry crop on red soils. In all, about 25,000 acres are under cultivation. The prices have fallen in recent years. Varietal tests of indigenous and imported varieties at Hunsur have shown that the selections from the local varieties, Pusa selections and Harrison Special are well suited to the locality. Under the local method of curing 30 to 40 maunds of cured leaf could be obtained. Over eleven varieties are now under observation. After the advent of Harrison Special variety—a cigarette type—curing barns have been built in the Hunsur area, Bangalore District, and Goribidnur Taluk. High grade golden-yellow leaves have been obtained by curing and they have met with good demand on the market. As a result of the success of the experiments conducted by the Agricultural Department and the Department of Industries, the Mysore Tobacco Company has been floated. Further extension of work is now being looked after by the Company.

Harrison Special variety has given very good yields of good quality in the light soils of Goribidnur under controlled irrigation. Mildew and leaf-spot have been kept down by spraying. In the Whitefield area the quality of leaf produced is good but the uncertain rains have been responsible for failures of crops. In the Hunsur area heavy yields of even over 15,000 lbs. of green leaf to the acre have been harvested but the leaves do not cure well. The heavy monsoon rains often stunt the crop and bring on a heavy attack of mildew and leaf-spot disease. Very careful investigation is necessary to keep in check the diseases. Improvements in the methods of curing are quite essential to secure a higher

percentage of first-class leaves. Cultural and manurial experiments are essential to improve the quality and the "body" in the leaf. Careful plant selection and breeding of desirable strains to suit the various localities are necessary to keep up a high class type of Harrison Special tobacco since the F_1 and F_2 seeds imported from America and Chirala segregate very badly.

On the Irwin Canal Farm under irrigation Anaikudi and Pusa hybrid 177 have given over 68 maunds of cured tobacco. Maryland, Havanna and Cigar types have also done well. Harrison Special has also given over 50 maunds of cured tobacco. A barn has been built on the Farm and the flue-cured leaves have given satisfactory results. There is every likelihood of this cigarette tobacco becoming an important crop in the canal area along with groundnut and cotton.

On the Babbur Farm Harrison Special made good growth and yielded heavily but the attack of mildew and leaf-spot disease were severe. On the other hand, a crop on the black soil was very successful. It had a healthy growth and the leaves were cured to a golden yellow colour with a good body. Where water is easily available to water seedlings after transplantation until they strike root, it is worth while extending this crop in the Chitaldrug District.

9. *Castor.*—The average area under this crop in Mysore is roughly about 100,000 acres. Chitaldrug has about 30,000 acres with over 25,000 acres in Challakere, Jagalur and Hiriyur Taluks. Challakere Taluk alone has over 16,000 acres under castor and is the most important taluk in the State for this crop. The whole district of Tumkur has about 27,000 acres under castor evenly distributed over all the taluks. In Mysore District the area is about 22,000 acres, large areas being found in Gundlupet, Chamarajanagar and Nanjangud Taluks. Kankanhalli, Closepet and Magadi form a block in Bangalore District with about 9,000 acres under castor. Though the climatic conditions are well suited for growing this crop we are importing about 30,000 maunds nett, costing nearly half a lakh of rupees. The average

yield of castor is about 200 lbs. per acre and if this is increased by even 8 or 10 lbs., we can check the imports considerably. An extension of cultivation by about 3,000 acres will be sufficient for the present. Challakere Taluk alone can stop this import by raising the average yield by 50 lbs. to the acre. Such a thing is quite possible by growing better varieties and by using a moderate dose of compost. Very good castor crops have been secured at Biligere in Mysore District by using the compost obtained from Mysore City. When rational feeding is fully appreciated and balanced rations for animals are generally adopted, groundnut cake will not be available for manuring commercial crops. For a crop of sugarcane of 50,000 acres at 3 tons of cake we require over 150,000 tons of castor cake representing nearly 350,000 tons of seed. To produce this quantity an area of nearly 3.5 million acres or a little over half the cultivated area in the State may be required. Castor is an important commodity and we are already short of our requirements. By growing improved strains and adopting rational methods of manuring we can considerably increase the output.

For over 20 years, 40 different strains collected in the districts are under observation. Of these collections *Channapatnada chittaharalu,* Settihalli, Bukkapatna and Bommanahalli varieties have given between 300 to 350 lbs. of seeds per acre at Hebbal. They were tested at Hunsur and it was found that though the castor crop made good growth the attack of borers and semi-loopers was heavy. The varieties vary from the small seeded *chittaharalu* to the big bold white seed. In habit they vary from annual forms to perennial tree castors which are largely used as shade to the ginger crop.

Twenty plant selections are under observation. H.2 and H.10 have given over 400 lbs. to the acre. H.2 has given as high an yield as 485 lbs. to the acre. They are closely followed by H.12, H.7 and H.6 which yield nearly 400 lbs. H.16, H.5, H.3, H.17 and H.8 have all given over 350 lbs. to the acre. As castor has male and female flowers separately on the same stock they are cross-fertilised

freely. By careful bagging and plant selection the purity of the crop can be kept up. The selected strains should be multiplied in isolated plots, heavily rogued and pure seeds obtained for distribution.

10. *Cocoanut.*—Over 50 lakhs of rupees worth of copra and cocoanuts are exported from the State and it is a most important commercial crop. The total area is about 160,000 acres of which 60,000 acres are in Tumkur District. Nearly half the area is located in one compact block spread over Channarayapatna, Arsikere, Tiptur, Gubbi and Chikkanayakanahalli. Tiptur Taluk alone has over 28,000 acres under cocoanuts. In this main area cocoanut is grown as a dry crop and a very efficient method of dry farming system is adopted in its cultivation. Copra produced there is ripened on the tree and has good demand in Northern India. There is good deal of variation in production between plants, in the number of nuts produced and in the quality of copra obtained. They vary in size, shape, colour, thickness of shell and kernel and percentage of copra to nuts. There is a good deal of variation in the quantity of husk in the varieties. Coir-making is practically unknown here as the nuts are ripened on the trees and the husks are used only as fuel. Since there is a large cocoanut trade there is no reason why the simple methods adopted in the West-Coast, should not be copied here as a cottage industry. At present, large quantities of coir are imported from Malabar.

On the Babbur Farm work on cocoanut has been seriously taken up by the Department. About 9 acres have been planted with selected nuts from the Huliyar gardens and there are about 350 palms available for making plant selections. The plantation is very young and the average yield has varied between 45 to 66 nuts per palm. Selections have been made for size, yield and quality of kernel in the copra. A large number of seedlings raised from selected palms have already been distributed. Scientific Assistants have also been sent out to Tiptur to inspect the gardens and select the best palms in all the important villages. Nuts from the best palms have been used for raising seedlings for general

distribution. It is hoped to have a large number of progeny rows of the best palms available in the State, at Babbur. If a cotton station is established on the Abbanaghatta Kaval the lower reaches fringing the tank bed will afford an ideal place for growing the seedlings of the best plants for producing nuts for distribution.

A number of exotic varieties has also been tested before. Dwarf nuts from Malaya were a failure. There is only one early bearing palm from Bansda State just now bearing at Babbur. Several plant selections brought by Dr. Leslie C. Coleman from Java are now making somewhat a tardy growth at Babbur. It is necessary to make a large collection on the Babbur Farm for comparative study of all the Indian varieties and exotic ones. They will be highly useful for hybridization work in due course. A beginning may be made by introducing tested varieties from Malabar, Travancore and Cochin.

11. *Wheat.*—The total area of wheat in the State is only about 2,000 acres. It used to be very much more. Kadur Taluk has about 800 acres and Chitaldrug and Hiriyur Taluks come next in importance. Consumption of wheat is steadily increasing in the State. About 23 lakhs of rupees worth of wheat and wheat flour are now being imported. Though the low prices on the market make it difficult for us to grow wheat cheeply, it is worth while extending the area to prevent the heavy imports. Promising strains from Pusa have been tested on the Irwin Canal Farm during the cold season. If sowings are made in the middle of August, the crop flowers in November and fair yields are secured. P. 52, P.4 and P.101 have given over 250 lbs. of grain per acre. P.80–5, P.12. P.3 and P.114 have also been tested and have given over 200 lbs. per acre. If seasonal conditions are favourable, about 600 lbs. of grain could be harvested—if suitable strains are secured both for the black cotton soil and the irrigated areas. We have to extend the area under wheat to about 80,000 to 100,000 acres to produce our requirements.

12. *Togari.*—There are about 120,000 acres under this

crop. Mysore, Tumkur and Chitaldrug are the important areas. In Mysore District alone there are about 25,000 acres and the other two districts have similar extent under *Togari*. *Togari* is largely imported from outside the State. Nearly 70 lakhs of rupees worth of pulses and grains are often imported. The present area should be trebled or the yield raised by 300% to provide our own requirements of pulses. *Togari* in Mysore is grown mostly as a dry crop. Pusa selections have given very heavy yields on the Irwin Canal Farm. T.51 has given the highest yield of 800 lbs. per acre. T.41 and T.16 come next with yields of 666 lbs. and 533 lbs. respectively. Other types T.80, T.82 and T.50 have also been tested. Some of them produce heavy tonnage of green matter and are well suited as green manures especially where the sann-hemp crop is badly attacked by the moth.

13. *Bengal-gram.*—Bengal-gram is largely used in the diet of Mysoreans. Over 50,000 acres are grown annually. Nearly half of this area is cultivated in Mysore District. The crop is usually a mixture of several types. The colour of the seed varies from black to light-brown. The crop is usually attacked by pod-borers. It is mainly a cold weather crop. Successful crops of Pusa types have been grown on the Irwin Canal Farm. November was found to be the best time for sowing there. T.58 has given the best yield of 635 lbs., T.25 has given 393 lbs. and T.17 only 302 lbs. On the Hunsur Farm Bengal-gram is taken as a second crop after kar-ragi. A collection of local varieties and testing them against new types from other stations will have to be taken up early to evolve types suitable for all areas.

14. *Other Pulses.*—Mysore, Tumkur and Chitaldrug are the important districts where nearly 780,000 acres are under horse-gram. Mysore District alone has over 280,000 acres. It is taken as a second crop after jola or kar-ragi. The system of cultivation in Tumkur is the best. There are several varieties grown. A preliminary cytological study has been made. Being the most important pulse crop both for cattle and man it requires immediate attention for improvement. Varieties which would produce more green matter are highly

useful in the Cauvery valley where it is extensively used as a green manure crop.

Avare is by far the most important legume largely used in the diet of the cultivators in the rural parts. Nearly 150,000 acres are under cultivation. It is largely grown in Kolar, Bangalore, Tumkur and Mysore Districts. There are many varieties. They vary in shape of pod, size and form of seed, colour of seed and productivity. Usually the flowers are white but some types have flowers of crimson colour. The infestation of pod-borer is very heavy. Varieties vary in their resistance to pod-borers and the store pest of Bruchid. In the *Malnad* areas where only one crop of paddy is taken it is worth while growing the winter crop of *avare* usually grown after paddy in the Konkan Districts. It is a small poded variety called *"Val"*. Arrangements are being made to test it at Marthur.

Cowpeas are largely grown in Mysore for seed. As a green manure for paddy they are popular in the Cauvery valley. Experiments on the Hebbal Farm have shown that they are good as green manures to the ragi fields. The small seeded varieties known as *thadaguni* are grown for seed. Large seeded ones are called *halasande*. Rangoon varieties produce more leaf as green manure crops. American cowpeas, especially the iron cowpeas, ripen early at Hebbal and produce good yields of seed. Punjab varieties also thrive here. As a cheap and easily digestible source of protein, cowpeas are a great asset in the diet of the people. At present there are only about 14,000 acres under cultivation. Production of good seed for green manure is a great necessity.

Soybeans have failed as field crops. Varieties from China and United States grow here but they do not develop the nodules. Two varieties from Java have done very well in garden lands and Kedale 16 and Kedale 30 under tanks. They have succeeded as field crops on the black cotton soils. Many cooking experiments have been conducted to see if they could be easily recommended to the ryots. But they do not lend themselves easily to our local preparations and cook well

like our local pulses and are highly indigestible. The varieties contain under our conditions about 15% to 17% of oil.

15. *Gingelly.*—The area under gingelly in the State is about 76,000 acres of which 29,000 and 19,000 acres are in Mysore and Chitaldrug Districts respectively. The value of exports is about Rs. 12 lakhs a year. There are several strains and seasons for cultivating them. Black gingelly is the main type. Recently a type of white gingelly from Raichur District has been introduced. Though it takes about three weeks longer to ripen, the yields are heavier and the oil content more than the local black gingelly. Arrangements have been made to import a large quantity of seed from Raichur for distribution. This white variety fetches a higher price and it has done very well at Adivala near Hiriyur under irrigation. As a dry crop at Hebbal it was very promising. In addition to its high oil content the flowers are very useful as bee-feed.

Local black and white gingelly are being tested at Hunsur. Many plant selections have been made and a few are worth noting. As the flowers are cross-pollinated by bees and other insects the breeding of this crop is a costly and laborious one. Since it is an important agricultural produce of export it requires a careful consideration.

16. *Coriander.*—There are only about 5,000 acres under this crop. Kadur, Mysore and Hassan Districts grow this crop but Ajjampur is the main trade centre. Often up to 4 lakhs of rupees worth of coriander is imported into the State. The black soils round Ajjampur are highly suited for this crop and its improvement will be taken up on the Ajjampur Cattle Farm. A collection of about 20 samples of coriander has been secured from different parts of India and they will be sown next season. The coriander used in medicine is a small seeded variety of Russia. It is highly scented. Arrangements are being made to secure this seed.

17. *Chillies.*—This is a very important crop as it supplies a necessary article in our food preparations. There are over 70,000 acres under chillies chiefly in Mysore, Hassan, Shimoga and Chitaldrug. Many plant selections have been made

at Marthur and the long-fruited ones are popular. Further selection work is in progress on the Hunsur Farm. As an irrigated crop on the Irwin Canal Farm as much as 80 maunds of dried chillies have been secured per acre. Everywhere there is a big local demand and there is some export trade from the *Malnad* areas of Shimoga District. Just now a demand for improved types has been created near Hunsur.

Plantation Products

18. *Coffee.*—The most important plantation product is coffee. Over 107,000 acres are under this crop in Kadur and Hassan Districts. This is the largest area producing coffee in India. Mysore coffee had a good reputation on the market but in recent years the quality is said to be deteriorating. The old *giri* coffee is still popular. The heavy attack of leaf rot is now successfully stemmed by spraying. By an organised campaign of pulling out dead bushes and treating the stem with "Tar distillate emulsion" the havoc of the borer is kept under check. The introduction of Robusta, Liberia and other hybrid varieties have not improved the industry. On the other hand by a free hybridization of various varieties by bees and other insects, the stock of good coffee plants is being slowly replaced by doubtful ones. Great care is necessary to select plants of the true Mysore type and multiply them. The Coffee Breeding Station at Balehonnur is doing work on these lines. Many promising plant selections are being multiplied. Grafting experiments have been successful and the method is being advocated for propagating desirable plants. Attempts are being made to isolate strains to resist the leaf disease. Germination tests made at Bangalore show that the vigour of the seed for germination can be safely predicted by observing the percentage of germination on the fourth day. A scheme for testing the quality of coffee has been accepted by the Imperial Council of Agricultural Research.

19. *Areca.*—There are 44,000 acres of areca-nut gardens. They are mostly found in the regions of heavy rainfall in

Shimoga and Kadur Districts. Areca is grown in *Maidan* taluks also in small patches under tanks. Kole-roga has been successfully checked by spraying in the *Malnads*. *Anabe* is causing some anxiety in the *Maidan* parts. There are many varieties in the nuts. The coarse '*Rama adike*' is of not much use but its greater resistance to Kole-roga may be useful in breeding work. Kalasa variety was tried at Marthur and the palms that are now bearing show no greater resistance to Kole-roga than the local ones. A sweet husked variety has also been noticed. Classification of the existing varieties and comparing their respective yielding capacities and the qualities of the different grades of nuts prepared, are points that require immediate study. Manurial experiments have been carried on for years on the Marthur Farm and they give very interesting results of value.

20. *Cardamom.*—Large areas of this are grown in Hassan and to some extent in all areca gardens in the *Malnads*. Varietal studies have been conducted at Balehonnur. Fruiting branches, shape and number of fruits borne vary. Raising seedlings, selection of plants and the multiplication of selected ones by dividing the rhyzomes will give much scope for improvement. Curing of fruits for colour and aroma on up-to-date methods are urgently needed for improving the marketing quality.

21. *Pepper.*—This crop is generally grown with areca in the *Malnads*. Its importance is slowly dwindling. New varieties of *Balamcata* and *Kallavally* have been introduced from Taliparamba and they are thriving at Marthur. Rooted layerings and cuttings of the improved varieties are being widely distributed. In the Mysore *Malnads* pepper grows wild. At Agumbe in Shimoga, Kempana Kote State Forest and Jog Falls numerous wild forms are found. Near Balehonnur once a giant form was secured. It is worth while making a search for more prolific types in the forest for cultivation.

22. *Plantain.*—Plantain is the most important garden crop. Several lakhs of rupees worth of fruits are being imported into Bangalore from South India. Out of about

19,000 acres grown in Mysore State nearly 8,000 acres are in Mysore District. *Rasabale* is our well-known variety. The Salem varieties are spreading in the Hiriyur Taluk. They bear well and stand transportation. Those varieties are now being multiplied on the Irwin Canal Farm for general distribution. Better facilities for marketing and providing money as crop loans are necessary to develop this industry.

23. *Mango.*—Nearly 18,000 acres are under this crop. Srinivasapur, Bangalore and Channapatna Taluks are important areas. The old gardens have failed and they are being cut down for fuel. New ones are not being planted. The famous *Badami* and *Rasapuri* varieties with attractive colour, good grain, size and flavour are fast disappearing. Reliable grafts are now not available and the trade in mango grafts is falling down. During the last four years experiments conducted at Peenya have shown that by judicious heavy pruning of trees the old gardens can again be rejuvenated. By cutting down the trees to about three feet from the ground and protecting the cut ends by a coating of tar and a thin layer of cement the main branches are forced to send out fresh shoots and they revive the trees in two or three years and begin to bear well. This method seems to be a very profitable one for reviving old gardens.

A beginning has been made on the Hebbal Farm to make a collection of all the well-known mango varieties. At present 25 varieties have been planted and many of them have begun to flower. It is proposed to collect types of fruits from all the well-known areas of Mysore like Malavalli, Nagar and Doddaballapur.

24. *Linseed.*—Small areas are sown with linseed in Mysore for seed. Seven improved strains were secured from Pusa and tested on the Irwin Canal Farm on the red soils with a few irrigations as a winter crop. Sowings were made in the middle of November and the crops were harvested in the middle of March. The yields were over 200 lbs. in all cases but No. 21 gave the highest yield of 564 lbs. of seed per acre. No. 68 gave 363 lbs. of seed. Other types tested were No. 10,

No. 55, T.12, T.121 and T.124. The crops are subject to heavy attack of mildew.

25. *Oats.*—Large quantities are imported into Mysore for feeding horses. Winter is the best time to grow it in Mysore. The vegetative growth is very good and good yields are obtained for fodder. The setting of the grain is very disappointing both at Hesaraghatta and on the Irwin Canal Farm. Four improved strains from Pusa were tested on the Irwin Canal Farm. If they are sown in September and harvested in January, fair yields are obtained. B.S. No. 1 has given about 770 lbs. of grain and B.S. No. 2 gave about 605 lbs. of grain per acre. Hybrid J. and Hybrid C. were also tested. For producing fodder for horses oats will do very well here but it will be cheaper to get seeds from North India for the present.

26. *Barley.*—Over 25 varieties of barleys were tested on the Hebbal Farm for the Breweries. The crop does not thrive here. A few strains were secured from Pusa and tested on the Irwin Canal Farm. All of them were failures. T.21 was the only type which made some growth when sown in September. If we can secure a type that could be grown here there is some demand for it in the Indian Breweries.

27. *Tapioca.*—Usually two varieties are grown here in the gardens. One of them is the bitter cassava. In Travancore Tapioca has become more or less a sort of famine food. Each plant produces often over half a maund of starchy swollen roots. Dr. Coleman selected and sent six of the best varieties available in Java during his visit and they have been multiplied on the Hebbal Farm. All of them are thriving and have no bitter taste. Some of the varieties have produced nearly a maund of roots when the plants are a year old. When the cuttings are planted in rows one foot apart and a foot in the row, tender roots like ordinary sweet potato can be obtained and they are very useful as a vegetable. They are easily cultivated as cuttings and stand droughts exceedingly well. Grown-up plants can thrive without rain or irrigation for over 6 to 8 months. It is highly desirable to multiply them rapidly and distribute all over the State

especially in the Kolar District and in the *Malnads*. As an insurance against famine, it is hard to outbeat this crop. The following varieties are now available for distribution: *A. Manji, A. Valenca, Md. Basiorao, Md. Tapicara* and *Md. Haparica*. All these have already been sent to Taliparamba on the West Coast for trials.

28. *Pineapple.*—Varieties of pineapple planted in the dry area on the Marthur Farm are thriving. A mulch of cane trash during summer months seem to be useful. Out of four varieties tested, Kew, Queen, West Indies and Mauritius, the quality of Queen is attracting attention though the Kew variety produces heavy fruits. Recently varieties have been imported from Cochin and planted on the Irwin Canal Farm. Under irrigation and intensive cultivation Kew variety seems to be a very profitable crop.

29. *Ginger and Turmeric.*—Both the crops grow well on the Marthur Farm. It is quite possible to grow all the ginger requirements of the Medical Department. Several attempts were made to improve the quality of ginger prepared for the market. Much remains to be done in improving the curing methods.

30. *Medicinal Plants.*—The commercial variety of *Senna* introduced from Tinnavelly is thriving on the Irwin Canal Farm. *Taraxacum, Fennel* and *Pyrethrum* have done well at Bangalore. *Rhubarb, Belladona* and *Hyoscyamus* grow well at Bangalore. *Ledgeriana* variety of Cinchona seeds brought by Dr. Coleman from Java germinated well here and a large number of seedlings were raised on the Baba-budan Hills.

Grasses and other Fodders

31. *Legumes.*—Sand Lucerne was found to thrive here. They have long tap roots and tied over droughts. They deserve more attention in our grazing areas. Other varieties do well under irrigation and give several cuttings a year. *Berseem* makes a fair growth in the cold weather but as a field crop it is a failure. *Seebania Egyptica* is a very useful legume for feeding cattle. Once it is established

during the monsoon even on dry lands, several cuttings could be had in a year. Welvet bean and Soy beans are useful if water for irrigation is available. Cowpea is very useful as a fodder either for feeding fresh green leaves or for making silage. Sannhemp sown in the tag end of the season makes a tolerably good growth for fodder and it can be easily grown during the seasons of scarcity when other crops fail. Algaroba plants introduced by Dr. Kunhikannan have grown very well here and the sweet pods are relished by cattle. Kamara plants produce very good leaves fit for feeding cattle and they require to be multiplied in all the dry tracts where famines are frequent. Sisso leaves are also useful for making silage.

32. *Grasses.*—All the local grasses found in the vicinity of Hebbal have been collected and grown in lines to study their habit of growth, yielding capacity and suitability to various soils. A large number of them were found to be annuals. Some are perennials. One of the Panicums is very similar to Guinea grass but grows on dry soils without irrigation. Three or four Ergrotis are good as freed feed. The rest are coarse and unfit for cattle. Many annuals like *Chloris-barbata, Panicum Javanicum, E. Egyptica* and *Digetoria marginata* are good for cattle and they grow as weeds in cultivated fields. Hariyali and *Panicum Indicum* thrive on wet soils. Lecrisia grows freely in the drains and wet channels. *Kolakattai* grass *P. cenchroides* from Erode grows fairly well but the quantity is low per unit area.

Among the imported grasses, a large number of varieties from Europe and America have failed. A few from New Zealand like Kikiyu also were not suited to our conditions. Natal grass has succeeded in dry lands. Napier grass of the thin type is thriving in dry soils. Napier grass of the thick type known also as elephant grass flourishes under irrigation. Johnson grass and Sudan grass have not grown satisfactorily. Guatamala grass which is very much like maize and closely related to it does fairly well as a field crop on dry fields. The hard seed-coat is said to bring on indigestion in cattle. Rhodes grass has come to stay as a good

grass. It persists on dry soils but thrives well under irrigation. Guinea grass provides with several cuttings per year under irrigation and is the cheapest grass for dairy purposes. Both Guinea grass and Rhodes grass require irrigation and heavy manuring along with irrigation and they do not stand salinity. Under such conditions the hardier Napier grass will do well.

Sun-flower has done exceedlingly well as a fodder crop. Along with jola it has been used for preparing silage. The seeds are very useful for feeding poultry and the oil has a good market. Maize is grown round about Bangalore for its cobs. Several varieties have been tested and discarded. The season of sowing has a great influence on the production of green matter. There are a large number of American long duration strains which are fit for fodder purposes and they may be profitably introduced and tested for securing desirable strains suitable for our seasons and soils.

Seed Production and Distribution

Promising strains are taken out of the breeding plots when they have given encouraging results in at least three years and then tested on the Farms in plots of 1|20 to 1|10 acre for some years to study their average performance. In every case the strains are tested against a local standard variety and the experiments are conducted on three plots at least to make an allowance for variation in soil fertility. Strains that have done well in these rigorous tests are sent out to the districts for preliminary trials. There are mainly two agencies through which the testing of varieties is pushed forward. The members of the Mysore Agricultural and Experimental Union and influential cultivators do the testing for the department under its supervision. Usually two or three strains which are likely to succeed are tested in each locality. The best of them, the one which satisfies the local requirement, is released for general distribution.

In the first instance the selected seed is sown on a private estate on one or two acres, cultivation, roguing, harvesting and threshing are done under the general supervision

of the Department. Such farms are termed by the Department as "A" grade farms. If the seed produced is good and it satisfies the purity, germination and vigour tests it is certified fit for seed purposes. The grower is given a premium of 10% for his trouble. Such farms for ragi are now scattered in many parts of the State and a few land-lords who took a keen interest in the work have been awarded with the Public Service Medals by the Government in recognition of the good work done by them.

Seed from the "A" grade farms is distributed to several selected growers in the locality. At the time of flowering and harvest the best fields are selected and the seed produced is taken over by the Department after necessary tests, for general distribution. These farms are termed as "B" grade farms. Thus in four years after leaving the Farm, the pedigree seed has a chance of getting into the field of the cultivator. The general spread by private distribution begins usually from the fourth year. By the time a new strain is produced and is released to the ryot's field a period of 8 to 10 years elapses and the various checks adopted in the tests and distribution ensures the release of only really good pedigree seeds. Doubtful ones are eliminated during the process of multiplication. At present attention is being paid to ragi only. Seed production on paddy, cotton and groundnut will be taken up as soon as possible.

Mysore State was the first province to organise a separate seed production section in the Department after the recommendations of the Royal Commission on Agriculture were published. A great demand for pure seeds of staple crops has been created in the State. The Co-operative Societies, Village Panchayats and the leading ryots are helping wholeheartedly in the spreading of new varieties.

Laboratory Work

There is a botanical laboratory and a large breeding cage at Bangalore. It is well equipped for giving help to the breeders. Critical breeding experiments and cytological investigations are conducted here.

Early in 1913 ragi was found to be a self-fertilised flower under dry land cultivation. This observation helped us to make a large number of plant selections in the fields and ultimately isolate H.22, H.2 and K ragies. Methods were evolved to germinate ragi pollen grain in moist chambers. By creating a dark moist chamber round the ragi flower it was found possible to induce the pollen sacks to emerge out of the glumes without bursting within the glumes. This method has been further elaborated at Coimbatore and it seems to be useful in the breeding work on cereals with small flowers.

The groundnut plant has been studied in detail and methods of hybridization have been evolved. Several hundred hybrids have been raised and studied. A large number of the homozygous segregates are now under plot tests. Cytological investigations showed that Small Japan has 10 chromosomes haploid and spreading Virginia 20 chromosomes haploid.

A large collection of wild American cottons have been made and seeds of some of them have been distributed to other cotton workers in India. By soaking the seed and cracking the hard seed-coat after the seed is swollen it has been found possible to easily germinate the wild cotton seeds. A method of germinating pollen grains of cotton on drops of castor oil in a moist chamber was found out. This will be useful in testing the vitality of pollen used in breeding work. Methods have been found to bud and graft cotton plants easily. It has now been possible to propagate original hybrids for observation along with the plants of succeeding generations. Further it has helped us to study the incidence of "Red Leaf" disease on different varieties of cotton by budding them all on one common stalk of a healthy tree cotton. The effect of stock and scion on one another has also been studied and interesting results have been obtained. Hybridization work on crossing the wild cottons of 13 chromosomes with the American cottons of 26 chromosomes has given very interesting results.

X-Ray work on sugarcane is in progress in the laboratory. Material treated here is sent out to the Farms for planting. Potatoes, groundnuts, paddies and cottons have also been treated with X-ray. Ragi seeds from the Farms and "A" and "B" grade seed farms and paddy, groundnut, jola and other seeds are tested in the laboratory. Nearly 900 samples are studied every year. Two extra hands are usually employed in the season for two months to help the permanent staff.

Post-graduate students work here for sometime and many of them have found employment in various places in India. One of the staff is in charge of the teaching work at Hebbal. A botanical garden is being formed at Hebbal to help the students in their study of cultivated crops and economic plants. The Section is often engaged in the preparation of exhibits for the Dasara "Industrial and Agricultural Exhibition" and other District Shows. A scheme is now before the Government for enabling at least six research students to carry on important investigations on the staple crops of the State.

SELECTIONS

Tobacco-Mosaic

Its Appearance, Cause and Control

At some stage in the history of most of the main tobacco-growing regions of the world tobacco-mosaic has become a serious problem to the grower. That the disease is now of minor importance in many of these regions shows that it may be controlled when adequate precautions are taken.

In New Zealand it is only within the last four or five years that tobacco-mosaic has become a major problem. As yet, there has been no organized attempt to control it. Provided strict precautions are taken, however, there is no reason why the disease should not be as effectually controlled here as in other countries. In this paper, based on experimental results published elsewhere (Chamberlain, 1937*), are indicated measures necessary for its prevention.

Appearance on the Plant

The most obvious symptom of tobacco-mosaic is a mosaic pattern of light- and dark-green areas on the leaves.† The design of this pattern is not constant, but the dark-green areas usually occur along the veins. A blistered appearance of the leaves sometimes results from more rapid growth of the darker green tissue. Leaf-spotting also frequently develops on infected plants, this type of injury being most prevalent on Burley varieties.

Plants which become infected early in the season are usually much stunted, while those infected later are not so much reduced in size. In the case of a severe attack, resulting from an early infection, the leaves are narrow, puckered, thin in texture, and often spotted, and are valueless for curing purposes.

When tobacco-mosaic attacks a plant late in the season symptoms show only on the new growth. Thus if a plant becomes infected during topping, mottling usually develops only in the laterals.

On seedling plants the symptoms are not so conspicuous, consisting of a few dark-green raised areas on two or three leaves. Such plants are usually smaller than healthy seedlings, and, in the seedling-beds, are often hidden by the leaves of adjacent healthy plants.

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* Chamberlain, E. E. (1937), *N.Z. Jour. of Sci. & Tech.*, Vol. XIX, No. 4, September 1937.

† Figures have been omitted.

Symptoms do not develop immediately after infection.—The mosaic mottling of the leaves does not appear until about two to four weeks after infection has taken place. The time taken for symptoms to show depends upon the rate of growth of the plants, being less than two weeks if they are growing vigorously and greater than four weeks if they are growing slowly.

Cause of Tobacco-Mosaic

Tobacco-mosaic is caused by one of a well-defined group of diseases known as plant viruses. The word "virus" is used to describe a large group of diseases some of which attack man, some animals, and other plants. A well-known virus disease of man is "infantile paralysis", and one of the best-known plant viruses is "tobacco-mosaic".

These two diseases show general similarities: both are spread by contact and are caused by minute organisms. They are dissimilar in that a person may recover from an attack of infantile paralysis, but a tobacco plant never recovers from an attack of tobacco-mosaic.

Plant viruses are usually spread by insects or by rubbing the juice from a diseased plant over the leaves or stem of healthy plants. The tobacco-mosaic present in New Zealand is the same as that which occurs in other countries.

Extent to which Tobacco-mosaic occurs in New Zeland.—It is only five years ago that tobacco-mosaic first began to be a serious problem to growers in the Nelson District. Since then it has increased to such an extent that to-day, it is the most important factor in the economic production of tobacco leaf.

An inspection of crops throughout the District has shown that the amount of tobacco-mosaic has steadily increased during the past four seasons. The estimated average percentage infection in 1933 was less than 10 per cent., while during the past season it appeared to be well over 25 per cent. The disease also occurs in the Auckland Province, but to a much lesser extent.

Effect on yield and quality of leaf.—In other countries tobacco-mosaic causes a reduction in crop-yield, and the leaf from plants infected early in the season is often valueless on account of its small size, thinness, poor colour, and spotting. Late infection up to the topping stage causes a slight reduction in yield and a lowering in leaf-quality.

The same is true of tobacco-mosaic in New Zealand, leaf-spotting being, in particular, a destructive feature of the disease in this country. In one crop of Burley tobacco, examined in 1933, leaf-spotting following mosaic was so severe that over 20 per cent. of the crop was left unharvested.

Trials in experimental plots at Palmerston North have shown that infection of plants shortly after they have been set out in the field

caused a reduction in yield of 44 per cent. in a Virginian variety and 78 per cent. in a Burley variety. Leaf from these plants was quite useless for curing purposes. Infection later in the season caused a reduction of 24 per cent. in the Virginian and 25 per cent. in the Burley variety. The leaf was of poor quality, but some of it was of a saleable grade.

Tobacco-Mosaic also Occurs on Other Plants

Many plants are attacked by tobacco-mosaic, the most important of these under New Zealand conditions being tomato, black nightshade, Cape gooseberry, Turkestan tobacco, egg-plant, and chilli. Of these tomato and black nightshade* are the only ones likely to play a part in the spread of mosaic to tobacco crops. The symptoms on these plants are similar: a light- and dark-green mosaic pattern on the leaves and a slight stunting of the plant. Leaf markings are less distinct than they are on tobacco and are sometimes difficult to distinguish. On tomatoes the leaves are sometimes narrowed and distorted.

Increase of the Virus in Diseased Plants

Although only a very small quantity of the virus is necessary to bring about infection of a healthy plant, it increases rapidly after infection has taken place. Thus, a well-known healthy plant may become infected if touched with a finger on which a small quantity of the mosaic virus is present. Three weeks later this plant would yield sufficient virus to infect every tobacco plant grown in New Zealand.

It has been pointed out that the symptoms of mosaic show only in new growth, and that a plant infected late in the season may show mottling only in the laterals. In such plants the concentration of the virus is as high in the older unmottled leaves as in young leaves showing mosaic symptoms. Thus a plant which has shown symptoms in the laterals only, will, after lateraling, appear healthy and yet be a source from which the disease may be readily spread.

In America it has been found that the virus is still active in the sap from diseased plants after five years, and that it may persist in the dried leaf for over thirty years. The evidence available shows that the disease may persist for several years under New Zealand conditions.

Occurrence in Smoking Tobacco

Tobacco-mosaic is not destroyed by the normal curing and manufacturing processes, and may be present, therefore, in prepared tobaccos. Overseas it has been shown that the disease is carried in

* Black nightshade is a common weed of gardens and cultivated land. It is often erroneously called "deadly nightshade".

many brands, and in some places smoking and chewing tobaccos are considered to be mainly responsible for the introduction of mosaic into the crops.

Experiments carried out at Palmerston North have shown that of nine samples of home-cured tobacco and sixteen samples, including nine brands, of manufactured tobacco, all carried mosaic infection. Home-cured tobacco carries the disease more readily than manufactured tobaccos. In some localities in America control of mosaic has been secured, in conjunction with other necessary precautions, by issuing to workmen tobacco which has been treated by heat to destroy the virus.

Heat Treatment

It has been found both in New Zealand and in other countries that, when heated for ten minutes, 195° F. is the lowest temperature at which the mosaic virus can be killed. Therefore, in order to destroy the disease it is necessary to maintain tobacco at a temperature in excess of this for ten minutes.

Heat does not penetrate readily into tobacco, and experiments have shown that a sufficiently high temperature cannot be secured by heating it in a tin either above or partly submerged in boiling water. A satisfactory way of destroying mosaic is to heat the tobacco in steam under pressure. Tobacco in 2 oz. sealed tins may be successfully treated in steam at 10 lb. pressure for fifteen minutes. This method necessitates special equipment, as an autoclave is required to obtain the pressure.

Steam treatment under pressure darkens the colour of the tobacco and alters the flavour slightly.

Infectious Nature of the Disease

Tobacco-mosaic is the most infectious plant virus disease known. The sap from diseased plants may be diluted to 1 part in 1,000,000 parts water and still bring about infection when rubbed on the leaves of healthy plants.

Infection can take place only through wounds, the disease gaining entrance most readily through very small injuries such as are caused by the breaking of leaf-hairs, which occurs whenever a leaf is touched. Thus, if the mosaic virus is present on the fingers, the mere touching of healthy plants is sufficient to infect them with the disease.

The ease with which infection may be brought about has been clearly shown by experiments carried out at Palmerston North. Sap from mosaic-infected plants was rubbed on the leaves of over 750 healthy tobacco-plants growing in the field, and all developed the disease.

Spread of Tobacco-Mosaic by Handling

In the field handling of the plants with contaminated fingers is the main method by which the disease is spread. Plants are handled a number of times during the season, affording many opportunities for the introduction and spread of the disease. Observations indicate that most of the infection takes place at the various times of handling—that is, at (1) pricking out of seedlings into the beds, (2) pulling of plants from the beds and transplanting to the field, (3) topping, and (4) lateraling.

The hands may become contaminated with the virus from (1) the infected tobacco plants already present in the crop, (2) smoking tobacco, (3) other infected plants such as tomatoes or black nightshade, (4) infected leaf or other plant-remains left over from the previous season.

Experiments were carried out to determine the extent to which the disease was spread during lateraling. Two workmen, after lateraling a number of infected plants, each lateraled one row of thirty-five healthy plants. When the crop was inspected three weeks later 83 per cent. of these plants had developed mosaic.

Rapid Spread towards the End of the Season

The amount of infection in a crop increases rapidly from the topping stage until the end of the season. Thus a crop which is showing 5 per cent. noticeable infection before topping may be 100 per cent. infected by harvest-time. Although the bulk of the leaf from such a crop may be normal in appearance and of good quality, it nevertheless carries mosaic infection.

The virus of tobacco-mosaic may be removed from the hands by thorough washing. It is not easily removed in this way, however, and to be effective the washing must be very thorough. It is advisable to use warm water, plenty of soap, and a nail-brush. Then, to remove all traces of the virus, the hands should be rinsed in running water or a change of water. Care should be taken not to recontaminate the hands from towels carrying infection.

Tobacco-Mosaic may remain alive in the Soil

The mosaic virus may remain alive in the soil during the winter and bring about infection of healthy plants in the spring. In rare instances it may survive two winters. The disease usually persists in the roots and stalks from infected plants of the previous season, but it may also occur in the soil in the free state. As a rule the amount of infection which takes place from the soil is small although occasionally it may be as high as 25 per cent.

Experiments carried out at Palmerston North have shown that

where tobacco-mosaic has been present in a seedling bed it may remain in the soil and infect the seedlings in the following season. In an instance where seedlings were pricked out into such a bed the plants, although they did not show the disease while in the seedling bed, showed over 11 per cent. infection after they had been transplanted to the field.

It has also been found that where mosaic-infected plants growing in the field are removed and replaced with healthy plants a high percentage of the replants develop the disease. Thus, of 129 healthy plants replacing diseased ones, 72 per cent. became infected.

Although many virus diseases are spread by insects, the results of investigations here and in other countries indicate that tobacco-mosaic is rarely if ever carried in this way.

In other countries it is generally held that tobacco-mosaic is not carried in the seed of tobacco. An investigator in Russia has claimed, however, that it may be carried in the dust which is often mixed with the seed. Preliminary trials in New Zealand suggest that the disease may sometimes be carried to a small extent either in or with the seed. Further trials are necessary before this question can be considered settled.

It has been shown in experiments at Palmerston North that tobacco-mosaic is carried in a small percentage of seed harvested from infected plants of tomatoes and black nightshade.

Measures for the Control of Tobacco-Mosaic

In outlining measures for its control it is stressed that tobacco-mosaic is very infectious and that it is essential to take the very greatest precautions to prevent its spread. The disease may be introduced in a number of ways, and field observations in the Motueka District indicate that the method of introduction varies from crop to crop. Control measures which are successful in one crop may, therefore, fail in another, so it becomes necessary to carry out all measures with equal thoroughness.

Control of tobacco-mosaic presents two problems: prevention of introduction of the disease to the crop and prevention of spread after the disease has appeared.

A. Prevention of the Introduction of Tobacco-Mosaic to the Crop

There are three ways by which the disease may be introduced: (1) with the seed; (2) through the soil; and (3) by human agency.

(1) *With the seed.*—At present no measures are taken to ensure that the seed used on New Zealand is taken from healthy plants. This will become a necessary precaution if it is shown ultimately that tobacco-mosaic is carried with the seed.

(2) *Through the soil.*—The disease is frequently introduced into the crop through the soil. Plants may become infected by means of contaminated soil in (*a*) seed-boxes, (*b*) seedling-beds, and (*c*) field.

(*a*) Seed-boxes: Soil used in seed-boxes should be steam-disinfected. When steam-disinfected soil is not available fresh soil should be obtained from land which has not been in tobacco or tomatoes for at least two years.

(*b*) Seedling-beds: Beds in which mosaic has appeared should not be used the next season unless the soil is replaced or disinfected with steam. New beds should be prepared on land which has not been in tobacco or tomatoes for at least two years.

If plants in a seedling-bed remain free from mosaic, the bed may be used a second season. All tobacco-plants should be removed as soon as possible after field planting has been completed, and the bed kept free from weeds until it is prepared for the new season.

(*c*) Field: The disease is carried over in the soil mainly in the roots and stems of the previous season's crop. The virus may also be leached out of such plant-remains and persist in the soil in the free state. Therefore, all roots and stems should be removed from the field as soon as possible after the completion of harvesting, and after drying in the sun, should be burnt.

(3) *By human agency.*—A great deal of infection with tobacco-mosaic takes place through the handling of plants with contaminated fingers. The many handlings to which the plants are subjected during the growing season affords excellent opportunities for the introduction of the disease. The fingers of workmen may become contaminated by handling (*a*) home-cured or manufactured tobaccos, (*b*) rubbish from previous season's crop, (*c*) cured leaf (often discard) left in sheds from previous season, or (*d*) other infected hosts.

(*a*) Home-cured or manufactured tobaccos: Since practically all tobacco carries infection, smokers working with plants should smoke only sterilized tobacco.* This precaution should be taken from commencement of pricking out seedlings into the beds until harvesting, and both at work and at home.

(*b*) Rubbish from previous season's crop: Owing to the high percentage of infection at the end of the season all tobacco-plant remains must be regarded as infected and capable of carrying the disease over to the next season. Therefore, after drying of the leaf is completed, all tobacco refuse should be collected from in and around kilns and sheds and destroyed by burning.

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* Until such time as arrangements can be made to have tobacco sterilized in the Nelson District, growers may have their tobacco treated free of charge by forwarding it to the Plant Diseases Division, Box 16, Palmerston North. Factory-made cigarettes cannot be treated.

(*c*) Cured leaf: All saleable leaf should be disposed of at as early a date as possible. Unsold leaf should be stored and not left lying in the sheds. All discard leaf should be burnt as soon as grading is completed.

(*d*) Other infected hosts: Mosaic sometimes spreads to tobacco from infected tomato or black nightshade plants.

If tomatoes are grown on the farm every care should be taken to see that they do not become infected. Thus all seed sown should be from healthy plants and the same precautions taken as when dealing with tobacco. As the symptoms on tomatoes are sometimes very slight and may not be noticed, the hands should be thoroughly washed after working with this crop.

On account of the inconspicuous symptoms displayed, black nightshade may act as an unsuspected source of infection. Mosaic is more likely to be present on this plant because of the ability of the virus to carry over in the seed. Special care should be paid to the eradication of this weed in the seedling-beds and surroundings. If plants are pulled the hands should be washed before again working with tobacco.

B. Prevention of Spread after Infection has taken place

Once tobacco-mosaic has been introduced it may spread rapidly through the crop. Spread takes place through the soil and by workmen.

(1) *Through the soil.*—Although tobacco-mosaic is not known to pass from diseased to healthy plants directly through the soil, it does spread from infected plants to healthy replants. It is suggested, therefore, that when making replants the infected plant be removed complete with a large shovel-full or surrounding soil. Before replanting the hole should be filled with soil from between the rows.

(2) *By workmen.*—This is the commonest method of spread of tobacco-mosaic. Unless a great deal of care is taken each operation which entails handling of the plants may bring about a marked increase in the amount of the disease.

Before pulling plants for setting out in the field the seedling-beds should be carefully inspected. If only a few infected plants are found, these, together with a group of surrounding plants, should be removed and destroyed. Where there are many infected plants in a bed it is inadvisable to set out any plants from it. The person doing the pulling should watch carefully for diseased plants, and when one is discovered it and a group of healthy plants surrounding it should be left unpulled. If an infected plant is accidentally pulled the person who has handled it should wash his hands before taking out any more healthy plants.

After plants have become established in the field they should be carefully inspected for mosaic. Plants showing infection at this stage do not produce any saleable leaf, and furthermore, act as a potent source of infection for the rest of the crop. They should be removed and destroyed and their places filled with healthy replants. Several inspections should be made at seven- to ten-day intervals.

The disease may be spread on implements during cultivation. So as much care as possible should be taken to prevent them from rubbing against the plants.

If tobacco-mosaic is present in a crop, a great deal of spread is liable to take place during topping and lateraling operations. To keep the amount of spread down to a minimum, one person should go through the crop ahead of the rest of the workmen and top or lateral all infected plants. This should be practised even late in the season when it is considered that mosaic will no longer affect the yield or quality of the crop, for, by keeping down the amount of infection, there will be less disease to carry through to the next season.

During all stages of growth of the crop, workmen should be careful to thoroughly wash their hands after handling diseased plants. To be effective, washing must be very thorough, it being advisable to use warm water, a nail-brush and plenty of soap. After washing, the hands should be rinsed in running water or a change of water.

Summary of Control Measures

(1) Use steam-disinfected soil in the seed boxes.

(2) Do not use a seedling-bed for a second season if tobacco-mosaic has been found therein.

(3) Establish new beds on ground which has not been in tobacco or tomatoes for at least two years.

(4) Keep the beds and surroundings free from weeds and stray tobacco-plants.

(5) Inspect seedling-beds prior to pulling plants for field planting, and remove and destroy any infected plants. If much mosaic is present in a bed, do not set out any plants from it.

(6) Workers handling plants should smoke only sterilized tobacco or be non-smokers.

(7) Avoid contamination from other hosts. To this end keep tomatoes free from mosaic and eradicate black-nightshade plants.

(8) Remove and destroy diseased tobacco plants as soon as they are noticed in the field.

(9) Remove the soil surrounding the infected plants when replacing them and fill in with clean soil before replanting.

(10) Avoid handling infected plants when working with healthy ones.

(11) Thoroughly wash the hands with soap and water to remove contamination whenever infected plants have been handled.

(12) Plough out roots and remove them from the field, together with stems and old leaves, and destroy by burning.

(13) Destroy all discard leaf as soon as possible after curing and grading is completed.

(14) Remove all tobacco from the farm at as early a date as possible.

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Tobacco Seed Selection

Tobacco plants have a natural tendency to variation and are very susceptible to changes of environment and climate. Unless rigid selection is practised, tobacco produced from locally grown seed will deteriorate.

Variation is due chiefly to changes in environment and to cross-fertilization between plants of different varieties and also between dissimilar plants of the same variety. By rigid selection and proper handling, seed can be obtained from plants of superior merit which will produce uniform tobacco of good quality.

The grower should select plants showing trueness to varietal type, which respond best to the peculiar soil and climatic conditions of the locality. For bright tobacco suitable for cigarette purposes, select plants with leaves fine in texture, thin, with fine venation and small mid-rib, and light in body. The best plants are those with a large number of medium-sized leaves, while the leaves themselves should have an erect habit of growth and little or no tendency to droop. Early maturing plants with leaves which assume a greenish yellow colour should be selected.

Having selected the parent plant, remove all the top leaves and sucker-branches leaving only three terminal flower branches for maturing seeds. The number of leaves left on the seed plant should correspond with the number left when topping the main crop. The flowerhead, when ready for bagging, resembles more or less a crow's foot. As uniformity is a very essential characteristic in flue-curing, it is best to bag the flower even if only one variety of tobacco is grown, because selected tobacco plants, when self-fertilized, have a prepotency in producing plants of similar habits. A cheap white crepe cloth bag should be placed over the flowerhead and tied loosely round the stem with a piece of twine. It is preferable to support the bag by means of

two sticks driven into the ground. Should any flowers open before the bag is put on they should be removed. The bag should be raised periodically as the flowers develop. When the bag is removed, any suckers and superfluous flower branches are nipped off and petals removed. When about 60 to 70 capsules have formed, the remainder of the flowers are cut and the bag removed. After removing the bag, the plants should be examined periodically and any suckers, buds or flowers which may develop later removed. Double the number of plants required should be selected because some of the selected plants may develop undesirable characteristics as they approach maturity. The seedheads should not be severed from the plants until the seed pods have turned brown, indicating that the seeds are mature. The seedhead should then be severed from the plant and stored with the pods pointing upwards in a cool store, in a place safe from birds and mice. When thoroughly dry, the seed should be shelled and winnowed and stored in a glass jar covered with fine muslin. Only heavy, well-developed seeds should be used for sowing. Light seeds should be removed by passing the seed through a tobacco seed grader.

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